ANNUAL REPORT

UPON

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE MISSOURI,

BY

E. H. RUFFNER,

FIRST LIEUTENANT OF ENGINEERS, U. S. A.;

BEING

APPENDIX R R

OF THE

ANNUAL REPORT OF THE CHIEF OF ENGINEERS FOR 1877.

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[EXTRACT FROM THE ANNUAL REPORT OF THE CHIEF OF ENGINEERS TO THE SECRETARY OF WAR.]

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 12, 1877.

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RECONNAISSANCES AND EXPLORATIONS.

The engineer officers on the staffs of the generals commanding the military divisions and departments have been engaged during the year in surveys in the field and in collecting and plotting geographical and other information obtained from the note-books, sketches, and maps made by the officers and soldiers in the scouts and campaigns in the West. The estimate of $50,000 made by this department for the surveys by these officers failed at the last session of Congress, and the only funds available for their use during the year was a part of a balance of $18,000 from a former appropriation for surveys for sea-coast defenses, which was also made applicable at the last session of Congress for reconnaissances and explorations by the engineer officers on the staffs of the western divisions and departments. The amount was quite inadequate for the work which was desired to be accomplished in the seven military departments embracing the country west of the Mississippi River, in each one of which there is an engineer or an acting engineer officer. This work includes surveys in the field by the department engineers, the purchase and repair of instruments, and the expenses attending the draughting and printing of maps required for distribution to the Army.

The maps of the country covered by the recent campaigns against hostile Indians have proved in the highest degree useful to the officers engaged, and it is especially desirable that the great unexplored areas in the hostile country and areas which in future campaigns are liable to be traversed by the troops or by the enemy should be surveyed and plotted and added to these campaign maps. The enlistment of topographical assistants to the engineer officers attached to the headquarters of each of the western military geographical divisions and departments which was authorized by the Secretary of War in July last will very much facilitate the surveys of those officers, and it is hoped, if the appropriation asked for for these surveys is granted by Congress, that much more can be accomplished than has been heretofore by the same amount of expenditure.

An estimate for the amount required to be appropriated for this purpose has been included in the estimates of this Department.

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Lieut. E. H. Ruffner has been on duty as the engineer officer on the staff of the general commanding the Department of the Missouri. The work of recording, preparing and making use of the reports of the various journals of march made during the year on the department maps is continued. The notes thus recorded amount to 4,909 miles. The notes collected on a survey of the headwaters of the Red River of Texas have been worked upon and a partial report is furnished.

Military reservations at Fort Stanton, New Mexico; Fort Elliot, Texas and Fort Reno, Ind. Ty., have been declared, surveyed, and recommended, respectively, and the plats form part of the records of the office.

Lieut. C. A. H. McCauley, Third Artillery, is engaged on a reconnaissance in the mining regions of Southern Colorado, to report on roads and number of settlers found. An allotment of $1,200 has been made for the service of the office for the year ending June 30, 1878, and an estimate of $5,000 made for the year ending June 30, 1879.

(See Appendix R R.)

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APPENDIX R R.

ANNUAL REPORT OF LIEUTENANT E. H. RUFFNER, CORPS OF ENGINEERS, FOR THE FISCAL YEAR ENDING JUNE 30, 1877.

EXPLORATIONS AND SURVEYS IN THE DEPARTMENT OF THE MISSOURI.

HEADQUARTERS DEPARTMENT OF THE MISSOURI,
OFFICE OF THE CHIEF ENGINEER,
Fort Leavenworth, Kans., July 16, 1877.

SIR: I have the honor to submit the following as my annual report for the year ending June 30, 1877:

Inasmuch as there was no appropriation available for the uses of the office during the year, no skilled labor was employed and no operations were conducted. An effort was made to finish work on hand at the beginning of the year, and to do something with new matter accumulated during the same time. The notes of the survey of the headwaters of the Red River of Texas have been worked on, and a report is made of the same and appended herewith. My principal trouble has been the loss of a professional draughtman. Sergeant G. A. Lichtenberg, Company D, Battalion of Engineers, has been on duty in the office throughout the year, and has made good progress and has been of more than ordinary service in the preparation and tracing of maps of various sorts. Lieut. C. A. H. McCauley, Third Artillery, and Lieut. T. M. Woodruff, Fifth Infantry, have been on duty in the office at different periods, and have been engaged in the preparation of the Red River report. Private H. Hartmann, Company C, Fourth Cavalry, was also engaged a part of the time as a draughtsman.

I have been employed myself in preparing the notes for platting and in working up the report, especially the meteorological notes and the water-color sketches.

No maps have been published by this office since the Indian Territory map in 1875, and none have been submitted for publication. Of the general work done in the department, the usual reports of scouts and marches are made, and although the movements of troops have not been extensive, still a fair number of miles is recorded. During the calendar year 1876 a total of 4,909 miles is reported, as compared with 5,341 during the preceding year. The members of the engineer detachment have been employed as usual in recording routes of march, in instructing enlisted men in the methods of topographical work, and at the engineer offices of the department. The value of the services of these men has been again shown, and the department commander has recently called my attention to his appreciation of their work, and has directed me to make application for such additional men as are needed to render the detachment efficient. The loss by suicide of Corporal William Holland, Company D, Battalion of Engineers, while suffering under an attack of acute melancholia, has been a serious one, and ex-

piration of term of service has reduced the detachment to three members at present.

During the summer of 1876, a chain measurement of Quartermasters' Freight Route No. 1, from Fort Leavenworth, Kans., to Fort Laramie, (now Wyoming Territory,) was done at the request of the Department of Justice, and the officer in charge, Lieut. C. C. Hewitt, Nineteenth Infantry, made the report as directed. This was unfortunately lost in the mails, and Lieutenant Hewitt prepared a duplicate report in this office which was copied and the copy filed here. The preparation of the map, which was platted on four sheets of double elephant paper, and then a reduced copy made for retention, occupied several weeks of the time of the draughtsman.

The reservation of Fort Stanton, N. Mex., was redescribed and published in general orders from these headquarters during the year, in accordance with the resurvey and the reduction as prescribed by act of Congress.

The preliminary papers for the declaration of a military reservation at Fort Elliott, Texas, have passed through this office, and a survey was made of the lines of the proposed reservation by Sergeant F. W. Maier, Company D, Battalion of Engineers.

A plat and a description of proposed reservations at Fort Reno, Indian Territory, for timber and for the general use of the post, have been prepared in this office, and are now under consideration by the proper authorities.

During my temporary absence on duty at the Centennial Exhibition at Philadelphia, from October 11 to December 30, 1876, the office was in charge of Lieut. T. M. Woodruff, Fifth Infantry. Lieut. C. A. H. McCauley, Third Artillery, now on duty in this office, is at present engaged in a prolonged reconnaissance through the mining regions of Southern Colorado, with orders to report exactly the number of persons at present engaged in these mines, and to examine the location and condition of all roads to these regions. He will also report in especial as to the capabilities of certain points for use as the location of a military post for the better protection of the settlers. It is not expected that Lieutenant McCauley will do any surveying, but he will make use of the maps furnished him by Lieut. G. M. Wheeler, through the Chief of Engineers, and locate his routes thereon. He will be engaged upon this work during the entire summer.

The following maps have been issued from the office during the past year:

Map of Indian Territory, 4 sheets	32
United States military divisions and departments, Engineer Bureau	3
Kansas, Indian Territory, and Texas, Engineer Bureau	1
Ute reconnaissance, 1873	2
Department of the Missouri, sheet No. 2	6
Department of the Missouri, sheet No. 4	6
New Mexico, Morrison, 1875	64
Miscellaneous maps	8
Miscellaneous tracings made and issued	11
Total	133

The sheets Nos. 2 and 4 of the Department of the Missouri maps are now out of print and the editions exhausted, and but few copies of the Ute reconnaissance maps remain.

An unexpended balance of the appropriation for surveys for military defenses having been again made available by Congress, an allotment has been made to this office for the present fiscal year of $1,200, and it

s hoped that an appropriation for the coming year will be made, so as to render the office again of the service that it has been in past years. Nothing especial is contemplated for immediate field-work, though, as shown above, it is very desirable that exhausted editions of useful maps should be replaced by new and improved issues, as was the original intention in the first preparation and printing, and the exigencies of the military service make field-work liable at any moment. Attention is invited to the accompanying report on the survey of the Red River.

Very respectfully, your obedient servant,

E. H. RUFFNER,
First Lieutenant of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

SURVEY OF THE HEADWATERS OF RED RIVER, TEXAS.

In accordance with verbal instructions from the department commander, and with a schedule of written instructions prepared by myself and approved by General Pope, I left this post on April 25, 1876, to make a prismatic-compass and theodolite and stadia-line survey of the head of permanent water of the Red River of Texas. The party took wagon-transportation from Dodge City to Camp Supply, and having obtained the necessary transportation at the latter point for the whole trip, went on to Fort Elliott, Texas. Here a suitable cavalry and infantry escort was obtained to do the necessary labor and give a proper protection during the work. Fort Elliott was reached May 6. The preliminaries of preparation were made and some work necessary to secure a good start was done, so that the party was able to leave on the 11th. The plan of work was as follows: The escort and train proceeded from camp to camp by the most direct line or trail, and this route was recorded by Sergeant G. A. Lichtenberg, Company D, Engineers, by means of the usual prismatic-compass and odometer readings. The start was made as early in the morning as it was light enough to read the instruments by, and except in case of an unusually long march, the new camp was reached by noon.

The stadia-line was run by myself. The meridian was determined by an astronomical portable transit at each camp, when practicable, and from the line so established the azimuth of the course was taken by a theodolite, and was preserved throughout the march by back sights from each station to the preceding one. The distances were obtained by use of the cross hairs of the telescope bisecting the two shields of an ordinary leveling-rod, which were separated, as directed by signal from the person at the theodolite, until the interval between the shields marked the angular distance of the two parallel horizontal wires of the reticle. The two readings of the shields were recorded, and the difference gave this interval in feet to the decimal of thousandths. The coefficient of distance was obtained by carefully chaining off on the ground a thousand feet, and then by repeated measurements getting the angular distance as given by the difference between the readings. The value in decimals of a foot for the stadia-interval was thus given for 1 foot, 100 feet, &c., on the ground in horizontal distance.

This coefficient was afterward tested by remeasurements at different times. The method is not intended for the most accurate of work, but under the circumstances the results were good. It was found that or-

dinary spider-lines were apt to sag in the early morning when the air was damp, and when the "mirage" became excessive in the heat of the day, difficulty was found in getting an exact bisection of the shields from their "dancing." The rate of work depended upon the facility with which the arrangements were carried out. The theodolite was carried on horseback, at a walk, the points of the tripod being inserted at the stirrup into a carbine-sling, as a guidon would be carried on the other side. It was found best to use two stadia-rods, alternately, as much depended upon judicious selection of stations. When the best conditions prevailed, between 2½ and 3 miles an hour could be run upon the open prairie. As high as 22 miles were made during a day's march. The distances were best maintained at about 1,500 feet, though one particular advantage of the system was well displayed in the crossing of cañons and wide valleys where chaining would have been difficult or impossible. Indeed, the best results of the method are found in rough country. The records when reduced were platted by latitudes and departures, and the error in closing from Mulberry Creek Camp to return to the same was about 1 per cent. Errors of azimuth were detected upon reaching the following camp and establishing the meridian again; and after a due allowance for convergence the remaining errors were not found to be material. The details of topography were recorded by the recorders of the stadia-rods, as well as on the prismatic-compass line, which latter was the longer, as the stadia-line went directly across obstacles which caused the wagons to make a detour.

Lieut. C. A. H. McCauley, Third Artillery, and Lieut. T. M. Woodruff, Fifth Infantry, assisted in the selection of the stadia-line and its stations, and enlisted men were soon taught to read the verniers of the level-rods correctly and kept good records. When passing through country where it seemed advisable, Ado Hunnius, draughtsman in this office, made topographical sketches at suitable points to catch the shape of the land. At other times he assisted on the stadia-line and Lieutenant McCauley took the necessary sketches.

Sergeant G. A. Lichtenberg, Company D, Battalion of Engineers, in addition to his other work, kept the meteorological record, and the manner in which the observations were taken will be found specified in the meteorological report annexed. During the march my own attention was given entirely to the stadia-line, but during our stay in camp I endeavored to take such geological notes as I could, and a brief *résumé* will be found under that head.

At night I established the meridian, when practicable, and for this and other reasons I carried with me a Würdeman portable transit, and as an experiment a frame-work which could be sunk in the earth and after being made solid by ramming the soil back again around the legs, could be used as the pier for the instrument. It was my intention to attempt to determine the latitude by the prime vertical and the longitude by lunar culminations, in addition to using the transit for meridian-lines and for time. I found, however, that I did not stay long enough in any one place, and at this writing I am disappointed in the results. The latitude of two points was attempted. One may be considered well determined. Observations for lunar culminations were made at two points and the reductions are not satisfactory to me; whether from lack of skill in the reduction or from inherent fault of the observations themselves, I am unable to state. Possibly I expected to do too much myself, and I should have succeeded better by taking more time and being more at ease.

Lieut. C. A. H. McCauley, Third Artillery, joined the party as a vol-

unteer and gave me great assistance in everything where intelligence, industry, and enthusiasm were expected. Although in bad health, he was always willing, cheerful, and efficient. He made a collection illustrating the ornithology of the region, and brought back an interesting series of bird skins, nests, and eggs. Besides this work, he rendered, as stated above, services on the stadia-line and in taking sketches of the topography. Upon returning to this point, he rendered me a full and interesting report on the ornithology of the region. He afterward furnished to the survey conducted by Dr. Hayden a copy of his report without mentioning the matter to me and requested its publication. This was done, and the report will now be found among the publications of that survey, to which it does not in any manner belong.

Lieut. Thomas M. Woodruff, Fifth Infantry, was engaged in his leisure moments in making such a collection of botanical and other natural-history specimens as his facilities allowed him to do, and his unwearied attention to this and his faithfulness in executing all duties intrusted to him are worthy of special mention. His reports on the specific duties performed by him will be found appended.

Lieut. F. D. Baldwin, Fifth Infantry, was in command of the escort, which consisted of eighteen enlisted men of the Fourth Cavalry and fourteen of the Nineteenth Infantry, and by his activity, energy, and attention to details caused the utmost smoothness to exist in all the work, and the surveying parties were always found ready for work, and uninterrupted by any annoyance or drawbacks.

Acting Asst. Surg. W. E. Sabin completed the *personnel* of the party.

The first camp was made at Cottonwood Creek, 12½ miles west from Fort Elliott, and a delay of a day enabled the party and escort to be suitably organized for work. The next day's march was 9½ miles west, to Big Springs, on the North Fork of Red River. Fort Elliott is beautifully situated on a high level between two of the heads of the Sweetwater, a branch of the North Fork. An abundance of fine fresh water and a heavy grove of cottonwood led to its selection. Not far off are fine groves on several of the adjacent streams, which have been heavily drawn on for the construction of the post and for the necessary fuel. On the north and west the edges of the upper level of the Staked Plains appear, and outlying buttes similarly capped with the hard white limestone, which preserves the upper layers and; until washed away, all that may be covered by it; are met with from the Canadian, down. Rolling country, well grassed in the spring, extends to the east and south, and the lower levels and valleys have as fine grazing as need be wished. The advent of the new post and the removal of the Indians have brought many settlers into the vicinity, and milk and butter and eggs are sold in ranches where three years ago a single company of cavalry was not too great an escort. Cottonwood Creek runs into the North Fork some 8 miles down below our crossing. A ranch was found on the creek, and growing corn. A particularly large grove of cottonwoods fills the bottom, and was the subject of the first water-color sketch submitted with this report. The country of the North Fork is much the same as the rest described, except that more sand is found than at any other point since leaving the Canadian.

Upon leaving the Big Springs we entered directly upon the general surface of the Staked Plains. From this point to the camp on McClellan Creek, and (excepting the slightly rolling vicinage of the Salt Fork) from that point until we came down the mesa into the Tule Cañon, we were on the upper level.

A description of a monotony may be tiresome and monotonous, but

the reality need not be. The long steady view or the gentle swell, and long, long wave of the quiet parched plain, has a strange fascination, and the slightest break to its vacuity has an alarming attraction. A withered "soap-weed" may be a forest; its dead last year's stalk of bloom may be a painted warrior. The wide shallow ponds may have water in them or not, according as pleases the sprites of the desert. The white swells of the canvas wagon-covers or tents may loom up and waver as though a mountain of snow in the distance, and the dancing, quivering heat and flame between you and them may be those of adventurous souls who have tried to reach the cool breath. The rabbit or the startled antelope may be the sudden vision that all eyes see, and the bleaching bones may seem to be herds of antelope, deer, elk, or what not animal, known or unknown. The first low swell ahead of you a hundred yards may magnify its short dried herbs to a distant forest in the misty morning, and the cliffs of the breaks 8 miles away may really be twice that.

The short withered grass, the famed buffalo-grass, grows everywhere, and the sad signs of many bleaching carcasses, and later in our journey the occasional tent and wagon of the buffalo-hunter, and the scattered bands, and their many halt, lame, and blind, show that the buffalo have no longer here a home.

As there had been little or no rain during the early spring, and as we had very little during our trip, the ponds or drain-basins, that are everywhere on the plains, had no water in them, though they were evidently wet during some part of each year. The hard, firm road made traveling easy everywhere for man and beast.

The point at which we crossed McClellan Creek was near the head of its water, and we had passed around the head of its north fork entirely. The creek was at that place in a cañon, some 100 or more feet below the general level. Upon our return we first struck the creek some 5 miles below this point, and here we met the finest grove of cottonwoods encountered on the trip. It was three or four miles long, and the valley was very pretty, with rolling hills, and a bottom in places a quarter of a mile wide.

The Salt Fork and Mulberry Creek were both pretty much alike, with a scant supply of good water, a few trees, and rolling ground at the upper breaks. Mulberry Creek, however, cañons soon and very deeply.

The next march brought us to the main cañon of Red River, and a gorgeous sight the first view of it was. Down one of its side cañons we looked on the strange scene. Cliffs of brilliant red sandstone were the main walls of the cañon, and the cap-stone the usual white limestone of the country. Lower down in the valley the sandstones are seen to be supplanted by clays and the gypseous mixtures of lime and sandstone and clays; the whole, so washed and twisted and shapen as to marvel the eye with its intricacy and daze it with its brilliancy, formed a wild and enchanting scene. So vivid are the colors that I have in vain tried to secure from one who has not seen such, the recognition due some of my copies of the tints; nay, though I have specimens of the colored clays and stones placed beneath the pictures themselves, they seem not to acknowledge them truthful.

Our camp, occupied near the head of the cañon, was called a permanent camp, and I submit a view of the cañon here. At this point I halted the party, and devoted a week to running a line to the head of water on the Palo Duro, the northern of the two streams which form the Red River. It had been said that this stream was many miles in length, but I traced it to its head with no trouble and then crossed south to

the other stream, called the Tierra Blanca. The route made by Col. J. I. Gregg, of the Eighth Cavalry, in 1872, was down this stream, and as he had been to the head of water there, it was not necessary to go farther. The heads of these streams and of the Tule, which was afterward ascended to a similar point, presented at these times a very lovely picture. We were above the cañons, and the low rolling banks of the courses were not enough to call hills. The fringe of brushes and low trees near the water opened into one or two groves on the Palo Duro, and the grass and foliage bore its brightest spring-green. The birds swarmed in the untouched wilderness and sang and twittered without ceasing. Antelope in great quantity and an occasional herd of mustangs gave life to the scene. The upper course of the Tierra Blanca lay through marshes and low, flat meadows, and the whole evidently formed a choice grazing-ground for a limited number of suitable animals. Doubtless we saw it at its best, but it must always be of value as a stock-range.

I have endeavored to represent accurately and without any exaggeration the vivid tints of this region in my two sketches on the Palo Duro and the Tierra Blanca. The water of the first stream contained small catfish within 2 miles of the head of water. The upper course of the Tule has an exactly similar country to this, and I went to the head of water there also.

During my trip up the Palo Duro, Lieutenant Woodruff ran a line to the Canadian, as described by him, and of which the two sheets 14 and 15 give the result. This was done to connect the work with the various surveys up that river.

At the permanent camp I took a sketch, which exhibits the character of the cañon there exactly. It is about 250 feet deep; and about 2½ miles below this point are the falls of the river. Here the stream breaks through the lower sandstone, the second hard rock of the series, perhaps 250 feet below the top of the cañon. The falls are about 30 feet high, and just below them the gorge may be 100 feet across and 50 feet high, besides the cañon above it, which may be 300 feet higher, and at the top one-third of a mile wide. Down this gorge I rode, having soon found a way to get down into it. At about 5 miles below, I found it gradually widening and becoming more like the cañon in the other places. When I came within sight of our first camp on the cañon-wall, given in sheet No. 6, I rode up on to the prairie and back to camp. At this point the cañon-walls may have been 450 feet high and half a mile wide. I am confident this is the place so vividly described in Marcy and McClellan's Red River Report, (p. 55,) as I have traced up or down every cañon which could fit their description, and this comes the nearest to doing it.

The narrowest and deepest cañon met by us, in a month's steady search of them, is that pictured by me as Tule Cañon, which is 500 feet deep by the barometer, and about a qaurter of a mile wide from top to top. The steepest and highest cliff seen is that painted in the center of the picture, and it is 125 feet by the barometer. During our stay in this region the closest search of the members of the party failed to detect or to find any signs of fossils in the main cañon or above it in the two creeks forming the main stream. I except from this statement the petrified trunks of trees which were occasionally seen, and petrified rootlets which were found in the upper clay just under the white or reddish-white limestone, which has been so often referred to as the capping stone of the region.

We remained five days in camp at the head of Cañoncito Blanco. This enabled me to take astronomical observations for longitude and

latitude, and to run a stadia-line down the canon, and to make investigations into geology. Here we were rewarded for the first time by the discovery of water-worn lamellibranchiata *Ostræa*, *Gryphæa*, and others, so worn as to be unrecognizable. The place where found, and a more particular description, will be given further on. This cañon is sharply cut, narrow, and soon very deep, reaching in about 2½ miles the same depth acquired by the main stream in 10½. There is found in the course of the stream, which contained fresh sweet water in a running brook, a narrow falls, some 15 feet high. At the last point reached by the stadia-line, as shown on Sheet No. 9, the view of the distant cañon of the main stream was very fine, and the wild masses of weather-worn rocks seemed in their strangest confusion and brightest colors. The channel of the river was about 4 miles distant from the last point reached on the mesa. The narrow cañon, as is the same case below the falls of the Red River, had a choice covering of deciduous trees, where the protection from storms and fires was perfect and the water in abundance. Birds found the cañon a natural abiding place; and there were tracks of bears, and perhaps a "mountain-lion," though we saw neither. An unfortunate buffalo straggled to the stream during our stay, and, though despised by his comrades, he seemed to be welcomed by our escort "with bloody hands to a hospitable grave." A heavy hail-storm on June 6 gave unexpected and unnecessary animation to our stay.

As we left this point, on the 7th June, a caravan of New Mexicans, with women and children, flocks and herds, came into camp, having taken the night for their march, as is preferred by them. They were going as settlers to the Quita Que country to the south of us, and as we were traveling over the field traversed, in 1872–'73–'74, by the cavalry in chase of renegade Indians, the sudden appearance of this peaceful hegira was an evidence of the improved state of affairs.

We found good water at our next camp, which was at the head of a small cañon as it broke through the mesa. Indeed, from what the guides reported, and from what I deduce from the geological relations of the region, good water may be found near the head of any side cañon to the west, or north and west of the main cañon at points where the two water-bearing rocks, the upper or limestone near the surface, and the lower conglomerate some 350 feet below the upper level, crop out into the section. I say *may* be found, and an inspection will soon show whether or not a search would be worth while; because the highest point or line on the plains is directly west of the main cañon, and the water flowing eastward is in general following a direct course, or, at most, is gathered by gentle slopes into troughs, which empty into the side cañons. Any water flowing into the streams from any source below the conglomerate may be tainted from the gypseous formation and its concomitants. So the streams to the north, Mulberry Creek and Battle Creek, have only a limited source of supply, and that from the north; while the side cañons of the main cañon to the south and east of the great bend need not be searched for good water.

In traveling up the bed of the main river from the mouth of the Tule, each side cañon to the left may be explored in the confident belief of finding good water in a distance of a mile at least, while the streams from the north and east, containing a much larger flow of water, are inexpressibly nasty to the taste—worse than the main stream in fact, and upon examination the sources of these side affluents may be found within a mile or so of the main bed.

The descent from the edge of the mesa into the cañon of Tule Creek was made with difficulty by the wagons, and the fall of about 1,000 feet was effected in 3 miles.

The topography of this region is well illustrated by Sheet No. 11. We were now fairly in the alkali region, and the water of the Tule was serviceable without the addendum of soap. The valley was verdant with rank vegetation, and through part of its course had good groves of deciduous trees. The camp was established at the mouth of the stream, and I went to the head of the creek and found it of the same characteristics as described for the Palo Duro and Tierra Blanca. The creek is, however, of good length and volume of water, and where it broke into its cañon I saw the finest exhibition met with during the trip of the perpendicular-walled cañon. It was impossible to descend with the horses, and only after some two hours of hard climbing did we reach the bottom. The barometer showed a fall of 500 feet. While making this trip we saw another New Mexican emigrant with two wagons at the crossing of the stream above the head of the cañon. My return to camp found the party amply satisfied with four days of epsom salts, and we were ready to move the next day. The sketch showing the mouth of Tule Creek is made from its south bank, and looking north the river-bed may be half a mile wide, and as it glitters in the sun is as dazzling almost as snow. The quivering heat and the disagreeable odor make the passage up its bed even for 3 miles, at 5 o'clock in the morning, anything but pleasant.

Our camp on Battle Creek was on the scene of an encounter between Col. N. A. Miles, Fifth Infantry, and the hostile Indians, on August 30, 1874. Between Tule Creek and D Company Creek we made two marches among the rolling plains and hillocks at the foot and along the edge of the Staked Plains. Just before reaching D Company Creek we crossed Mulberry Creek. These streams have a limited supply of brackish water, and, although they may furnish a limited area for stock purposes, they will not, I fear, ever be of much value.

The scrubby cedars, which enjoy a growth in all situations where sand and drought make their existence pleasant, are here found, as well as scattering on the sides of the cañons anywhere and everywhere. We killed at D Company Creek a black bear, the only one seen on the trip, and a scrubby fellow at that.

During the camp at the mouth of the Tule the party feasted on deer, antelope, buffalo, young and old, to their heart's content, and until pork again grew to be a luxury.

We were now in the buffalo country, but, instead of the countless herds of five years before, the bands were small and not numerous. Thousands ran where tens of thousands were found in 1872, and the great numbers of maimed who had, though wounded, escaped the knife of the buffalo-hunter, testified to the approaching doom.

We encountered these herds from this time until our arrival at Camp Supply, and we met occasional parties of hunters hanging on the flanks of the herd. The buffalo are already so few in number that the pursuit is not very remunerative, and I doubt if any who were out made much more than a fair living by their campaign. Indeed, one of our scouts told me "it didn't pay," and as he himself was engaged in this work when most attractive, and had made with one partner $975 in two weeks, from skins obtained in the Arkansas Valley, in 1873, he probably knew. He gave me this as the best he had done.

From D. Company Creek we again ascended to the plains and connected our line with that of the outgoing part, at the camp at Mulberry Creek. Leaving the party in camp here, I rode southwest to the cañon again, and down and across it to a point not far from our Camp Cent. Lieutenant McCauley had made a reconnoissance from the camp on Tule Creek up to this point, and I now connected my line with his. A part

of the topography thus given is found on the sheets, but the whole cannot be put down until a general map is made; but I have not as yet been able to commence this. The cañon here has magnificent proportions. At the point where I descended the walls, it may be 8 miles wide, though it spreads as the lower course of the stream turns southwardly. The upper walls may be 300 feet high, and a plateau then stretches to near the river proper. The plateau is seamed with water-courses, and the main walls are indented by "breaks." The river-bed has immediate inclosing-hills of 300 or more feet in height, and on the west the mesa-walls rise nearer the river and are more sharp. The short water-courses of the plateau are the affluents from the north quoted by Marcy and McClellan. During this ride I found a few shells in a conglomerate, about 200 feet or more above the river, and at the place we camped. Perhaps the spot was 3 or 4 miles from Camp Cent. During my absence Lieutenant Woodruff ran a short line down Mulberry Creek, and the evening of my return to camp was celebrated by a brisk hail-storm and an attempt at stampede of the mules.

From this point we returned directly to Fort Elliott. The line of march was to the east of that taken on the outward march. The prismatic compass-line was the only one recorded on the return.

We camped on McClellan Creek, at the junction of its two forks, and in the fine grove of cottonwoods already spoken of. Reaching Fort Elliott June 21, the escort was returned to duty at its post, and it gave me pleasure to express to the commanding officer the entire satisfaction felt at the willingness, interest, and soldierly bearing of the escort, during their performance of the duty expected of them.

We arrived at Dodge City on June 28. The general mileage made was as follows:

	Miles.
Stadia line complete	260
Prismatic compass-line	450
Horseback reconnaissance	175
Total	885
Fort Dodge to Fort Elliott and return	370
Total mileage surveyed and by wagon	1,255

The general results were gratifying in showing that my map of the Indian Territory was quite correct, and my survey but confirmed my deductions and conclusions from prismatic compass-lines already on hand.

On working up the report I have met with much difficulty. Soon after coming back Lieutenant Woodruff was detailed in the office to work up his own notes, but was soon relieved and went with his regiment to Dakota. Lieutenant McCauley was afterward on duty but to be relieved and ordered to Washington. I myself was absent two months and a half, and I had no funds to hire a draughtsman. I have made some remarks in my geological notes which may be of interest as to the features of the country. As to its economical value it will be recollected that my notes commence and end at or near the Staked Plains, and that, whatever may be the future of the country, the needs for it are not apparent as yet; and with the miles and miles of fair grazing-land in the Indian Territory and in Kansas as yet unflecked with peaceful herds, I see no reason for speculating on the use of the Staked Plains. For the present it will suffice us to know where we may go and how we shall best travel, and where the best roads, wood, water, and grass may be found.

REPORT OF LIEUTENANT THOMAS M. WOODRUFF, FIFTH INFANTRY.

FORT LEAVENWORTH, KANSAS, *February* 1, 1877.

SIR: I have the honor to submit the following report upon my trip from the permanent camp on Red River to the Canadian River:

In accordance with your instructions to run the stadia line up to the Canadian River, I organized my party, consisting of Sergt. G. A. Lichtenberg, Company D, Engineers; scout Dixon, with one corporal and eight men; one wagon and seven-days' rations and forage, as follows: To Sergeant Lichtenberg I intrusted the keeping of the prismatic compass and odometer readings. The scout Dixon and Corporal Merriam, of Company M, Fourth Cavalry, rode some distance in advance and chose stations. Private Replogle had the stadia rod, and privates Hall, Kirch, and Hope assisted me as flagmen. I myself took Aloe theodolite No. 93. Scout Dixon informed me that it was quite a long distance from the permanent camp to the next water; therefore, in order to gain time and run the line more quickly, I left the camp at 1 o'clock on the 23d of May, taking only the working party, and ran the line out about 5 miles. I returned to the camp about 6 p. m. The afternoon had been cloudy, but very cool and pleasant.

At 5 o'clock on the morning of the 24th of May, I left the camp with my whole party and reached the last station of the previous day at 6.30 o'clock. The morning was cold and cloudy, with a heavy mist; cool, northerly wind. Everything, however, was favorable for taking readings, and I made rapid progress until 9.30 o'clock, when the sun came out very bright, driving away the mist. Soon after this, and during the remainder of the day, the mirage troubled me a great deal, and the heat was intense. About 11.30 o'clock a troop of about a dozen wild horses came very near my party—so near, in fact, as almost to stampede our horses. The wild horses were very fleet, and were not at all curious, for they kept on their course without stopping. They presented a beautiful sight as they galloped swiftly past.

Scout Dixon had conducted the wagon and the portion of the detachment not working with me to a point near the head of the Rio Piedroso, where we camped, reaching this place about 3.15 in the afternoon. The distance from the permanent camp was 17 miles 1,137 yards. The country over which we had passed during the first part of the day, for about 14 miles presented all the characteristics of the Staked Plain; the remainder was gently rolling, indicating the proximity of a stream. At our camp we found a series of pools of good, clear water, apparently permanent springs. There were a few cottonwood trees, and the grazing for the animals was good. While my dinner was being prepared I made collections of botanical and entomological specimens, which were about the same as those that I had collected at the permanent camp.

On the 25th I broke camp at daylight and left at 5.20, taking nearly a northwesterly direction; the country became more and more hilly, and finally very much cut up with deep arroyas. We reached camp about midday, having made 10 miles 881 yards. The day was cool and pleasant, and fine for working. Our camp was located about a mile above the mouth of May Creek, which runs into the Canadian. As we neared the Canadian I noticed that the hills were composed largely of drift, with outcroppings of limestone and red and yellow sandstone. Our camp on May Creek was in a very pretty little grove of cottonwood. The water here was not very good, being slightly alkaline. After dinner I walked down the creek to the river, which I found contained a large flow of water, and the bed was about 300 yards wide. On the north side of the Canadian the bluffs were more abrupt and higher than on the south. On the west bank of May Creek, right at its mouth, there is a hill about 60 feet in height, on the top of which I found a space of about 12 feet square, marked out by stones; it seemed to be a grave, and after digging and scraping around with my sheath-knife I found several arrow-heads of flint. I should like to have investigated this further, but I had to return to camp before darkness set in.

On this same day Sergeant Lichtenberg and scout Dixon went some 5 miles up the river, the sergeant making a very accurate topographical sketch accompanying his notes.

On the 26th I broke camp at daylight. I sent Sergeant Lichtenberg with a small guard and the wagon back to our camp of the 24th. I ran the stadia line about 5¼ miles down the river; it consumed a great deal of time, owing to the very rough nature of the ground. My last station was on a very high hill, near the mouth of Muster Creek or the Arroya Bonita, in the valley of which, some 3 or 4 miles distant, were several large cottonwood groves. On the hills that I this day passed over, I remarked the frequency of cedar trees, of a rather stunted growth; there were some, however, that attained considerable height. I suppose that the general level of the tops of these hills, which were largely composed of gravel, was about 150 feet above the valley of the Canadian. A little below the mouth of the Arroya Bonita the Canadian makes a sharp turn toward the north, forming, I suppose, the Great Bend. From our camp of the previous night to this point our course had been nearly east. After making a topographical sketch I assembled my party, and taking about a southerly

course over country similar to that that we had just passed over, we arrived at ou camp of the 24th instant about 2 o'clock, having had a very hard day's work.

On the 27th I broke camp at 5 o'clock, and reached the permanent camp on Red Rive at 10.30 a. m. It is a curious fact that during the three nights, while I was on thi reconnaissance, we had very heavy rains, accompanied by thunder and lightning, an this in a region that has always been thought to be very dry.

I am, sir, very respectfully, your obedient servant,

THOS. M. WOODRUFF,
Lieutenant Fifth Infantry.

Lieut. E. H. RUFFNER,
Corps of Engineers,
Chief Engineer Department of the Missouri.

METEOROLOGICAL REPORT.

As the country to be traversed was but a rolling prairie, and the di ferences in altitude were not expected to be very great, it was though a constant reference could be made to a barometrical base at Dodg City; one of the stations of the signal-service of the Army; a point a no time more than 225 miles distant from the working parties. An inaccuracies arising from the necessary assumption that abnorma changes of pressure at the one station were probably equally experi enced at the other, were believed to be less than would be errors in th determination of a mean barometrical reading for a station occupie for the short time which could at best be devoted for this purpos Two or three points were to be determined by several days' barometrica observations, and the difference of altitude between these points an Dodge City being determined by this series, the relative altitudes o neighboring points would probably be fairly accurate.

In conducting the survey three points in the field were occupied lon enough to enable parties to make surveys in various directions, thu determining at the same time with the other work profiles of the line surveyed. The instruments used were a mountain barometer, No. 392 made by J. Green, of New York, and two aneroids made by Cassella and marked B and C. The tube of the mountain barometer wa broken twice on the trip, but the frequent comparisons between th aneroids and the mercurial during the survey, and the comparison be tween all of these instruments and the barometer at the Dodge Cit station, both going and coming, gave satisfactory results, and prove the instruments to be good ones. I did not have a wet-bulb thermom eter, and the observations for humidity are therefore wanting. As th general character of the country is very nearly the same as at the me teorological base, it is probable that but little difference in the conditio of the atmosphere arose from this reason, and it is certain that th error arising from the omission of the humidity-terms is less than tha which necessarily was introduced by the starting assumption of com paring our observations with the distant base.

HORARY CURVES.

Horary curves were determined wherever practicable, and great car was taken that these observations should be as accurate as possibl The following table of corrections is given, determined on the date noted

	Dodge City, Kans., April 26 and 27, and June 28 and 29.	Fort Elliott, Tex., May 6 and 10, inclusive, and June 21 and 22.	Tule Creek Camp, June 9 and 11, inclusive.	Camp Supply, April 30 and May 1 and 3, inclusive.	Mulberry Creek, June 17 and 18.	Cañoncito Blanco, June 5 and 6.
Altitude.	2,479 feet.	2,595 feet.	2,290 feet.	1,901 feet.	3,106 feet.	3,491 feet.
a. m	−.011	−.039	−.076	−.004	−.035	−.031
a. m	−.040	−.048	−.067	−.037	+.003	−.017
a. m	−.043	−.039	−.050	−.055	+.011	−.023
a. m	−.044	−.034	−.032	−.063	−.005	−.033
a. m	−.044	−.014	−.022	−.050	+.002	−.041
m	−.025	−.005	−.012	−.026	+.001	−.022
p. m	+.003	+.016	−.004	−.002	+.003	−.011
p. m	+.006	+.030	+.007	−.008	+.011	−.007
p. m	+.027	+.031	+.032	+.014	+.015	+.057
p. m	+.040	+.046	+.060	+.058	+.015	+.050
p. m	+.044	+.027	+.083	+.071	+.019	+.060
p. m	+.053	+.026	+.083	+.074	+.018	+.053
p. m	+.053	+.014	+.059	+.088	+.015	+.040
p. m	+.033	−.004	+.034	+.081	+.011	+.025
p. m	+.004	−.033	+.028	+.028	+.007	+.036
p. m	−.004	−.016	+.020	.....	.....	.....
p. m	−.015	−.023	+.015	.....	.....	.00
a. m	−.008	−.011	+.013	.....	.....	.....
a. m	−.012	+.012	−.010	.....	.....	+.012
a. m	−.009	+.034	−.021	.....	.....	.....
a. m	−.014	+.047	−.032	.....	.....	.....
a. m	−.002	+.020	−.033	.....	.....	.....
a. m	−.023	−.017	−.047	+.002	.....	.....
a. m	−.008	−.029	−.068	+.003	−.055	−.023

A partial determination of horary corrections was made at the following points:

	Permanent camp Red River, May 21, 28, 31, inclusive.	First camp on Red River, May 18 and 19.
Altitude.	3567.7 eet.	3434.
a. m	−.049	−.083
.27 a. m	−.059	−.074
p. m	+.047	.....
p. m	+.072	+.049
p. m	+.020	+.034
p. m	+.007	.....
a. m	−.038	−.086

These tables are prepared from, at best, but a limited number of observations, and should not be considered as more than approximate. At the individual points, however, the determinations seem to have been fairly accurate, judging from the closeness of the range. At Dodge City the horary curve was determined for April 26 and 27 and for June 28 and 29. The mean of the range between individual hourly results, as de-

termined by the two series, is 0″.013 of the barometical scale. Althoug probably an accident, this close agreement between results at times tw months apart shows that the values of the corrections are probably safel close in calculating the differences of altitude during the intervenin period. Five days' record at Fort Elliott and four at the camp on Tul Creek gave each as the mean of the range in the results for determina tion of individual hour corrections 0″.019 of the scale. This close agree ment is also a satisfactory evidence of probably equally accurate and clos results. These three points have about the same altitude, and are bu a degree distant in longitude. We might expect, I presume, a close agreement between the three curves than is exhibited, but I think my self that the location of the camp on Tule Creek, being in a cañon 1,20 feet deep, with walls at least 4 miles distant in any direction, and thu probably affected by rapid heating of the somewhat confined body o air, probably presents causes for rapid and great variation of the pres sure not experienced by the prairie-situations of the other two points The curve at Fort Elliott was determined from the mean of five days observations, excepting the corrections for the hours between 10 p. m and 5 a. m., which depend upon one day's observations only. If we omi these hours, we shall see a close agreement between the curves of thi place and of Dodge City. It may not be uninteresting to compare th table of corrections obtained by taking the mean of these two determi nations with the table used by Lieutenant Whipple, in his survey of th 35th parallel, (Pacific Railroad Reports, vol. iv, p. 257,) and applied to th barometical observations between camp 32 and the Laguna Colorado essentially the same country.

The scale used by Lieutenant Whipple was deduced from observations at Washington and Philadelphia, and modified to conform to the sup- posed climate.

The mean deduced by myself may be considered as that of seven days' observations in May for a point at an altitude of 2,500 feet, latitude 35° 30′ and longitude 100° west from Greenwich. The differences given between the two series are obtained by subtracting Lieutenant Whipple's curve from mine.

TABLE COMPARING HORARY CORRECTIONS.

	Lieut. Whipple 1853.	Lieut. Ruffner, 1876.	Difference.
6 a. m	−. 007	−. 018	−. 011
7 a. m	−. 020	−. 025	−. 005
8 a. m	−. 030	−. 044	−. 014
9 a. m	−. 040	−. 041	−. 001
10 a. m	−. 050	−. 039	+. 011
11 a. m	−. 055	−. 029	+. 026
12 m	−. 025	−. 015	+. 010
1 p. m	−. 005	+. 009	+. 014
2 p. m	+. 015	+. 018	+. 003
3 p. m	+. 030	+. 029	−. 001
4 p. m	+. 045	+. 043	−. 002
5 p. m	+. 050	+. 036	−. 014
6 p. m	+. 030	+. 039	+. 009
7 p. m	+. 020	+. 034	+. 014
8 p. m	+. 005	+. 014	+. 009
9 p. m	+. 000	−. 014	−. 014

The agreement between the two series from and after the 12 m. co rection is noticeable. The maximum of Lieutenant Whipple's curve wa placed at 11 a. m., an assumption which later authorities have corrected I believe at most of the interior stations of the United States the maxi

ıum is now given between 9 and 10 a. m., or nearly there. Of the re-
ıaining series, the one at Mulberry Creek is not considered reliable, as
ıe determination rests upon 24 hours' readings only, and the only really
iolent storm of the trip occurred there. The camp was situated also
ı a narrow cañon, and I am now inclined to believe such locations en-
rely unsuitable for barometrical observations.

Thinking that the elements used in calculating the various horary
ırves might be of service in the future, I have prepared the following
ıble, giving the horary corrections as determined by each day's obser-
ations, and following the mean of the results for each is the mean of
ıe variations of individual results from their mean.

HORARY CORRECTIONS AS GIVEN BY THE OBSERVATIONS DURING EACH 24 HOURS.

	Dodge City, Kans.			Fort Elliott, Tex.							Tule Creek, Tex.				
				May—				June 22.	Mean.	$\frac{\Sigma v}{m}$	June—			Mean.	$\frac{\Sigma v}{m}$
	April 26 and 27.	June 28 and 29.	Mean.	6.	7.	8.	10.				9.	10.	11.		
7 a. m	−.025	−.002	−.011	−.042	−.019	−.029	−.047	−.053	−.039	.011	−.096	−.056	.....	−.076	.020
8 a. m	−.059	−.022	−.040	−.082	−.029	−.019	.....	−.060	−.048	.024	−.072	−.063	.....	−.067	.005
9 a. m	−.048	−.038	−.043	−.062	−.029	−.009	.....	−.059	−.039	.018	−.073	−.044	−.034	−.050	.015
10 a. m	−.043	−.044	−.044	−.052	−.019	+.001	−.057	−.045	−.034	.020	−.061	−.020	−.015	−.032	.019
11 a. m	−.039	−.049	−.044	−.012	−.009	+.031	−.047	−.033	−.014	.021	−.049	−.004	−.009	−.022	.017
12 m	−.035	−.015	−.025	+.008	+.011	+.011	−.037	−.020	−.005	.016	−.040	+.010	−.004	−.012	.019
1 p. m	+.016	−.011	+.003	+.028	+.021	.....	+.013	+.003	+.016	.009	−.007	+.021	−.026	−.004	.033
2 p. m	+.009	+.003	+.006	+.058	+.021	.....	+.013	+.022	+.029	.015	+.023	+.041	−.042	+.007	.033
3 p. m	+.027	+.027	+.027	+.078	+.021	+.001	+.023	+.029	+.031	.019	+.052	+.056	−.011	+.032	.029
4 p. m	+.049	+.031	+.040	+.088	+.021	.....	+.033	+.042	+.046	.021	+.084	+.086	+.010	+.060	.032
5 p. m	+.042	+.046	+.044	+.058	+.011	+.001	+.023	+.044	+.027	.019	+.074	+.124	+.051	+.083	.028
6 p. m	+.047	+.060	+.053	+.028	+.001	.....	+.043	+.037	+.027	.013	+.089	+.118	+.039	+.083	.028
7 p. m	+.043	+.064	+.053	−.028	−.049	+.021	+.053	+.019	+.015	.025	+.054	+.090	+.033	+.059	.021
8 p. m	+.038	+.028	+.033	−.002	−.049	−.039	+.053	+.019	−.004	.032	+.056	+.001	+.049	+.034	.023
9 p. m	+.006	+.002	+.004	−.042	−.079	−.039	−.007	+.002	−.033	.024	+.045	+.004	+.035	+.028	.016
10 p. m	−.004	−.004	−.004	.....	.....	.....	.....	−.016	−.016	.....	+.028	+.007	+.025	+.020	.009
11 p. m	−.009	−.020	−.015	.....	.....	.....	.....	−.023	−.023	.....	+.021	+.009	+.032	+.021	.016
12 a. m	+.010	+.006	+.008	.....	.....	.....	.....	−.011	−.011	.....	+.023	+.003	+.014	+.013	.007
1 a. m	−.012	.....	−.012	.....	.....	.....	.....	+.012	+.012	.....	+.005	−.069	+.033	−.010	.039
2 a. m	−.009	.....	−.009	.....	.....	.....	.....	+.034	+.034	.....	−.007	−.071	+.016	−.021	.033
3 a. m	−.015	−.013	−.014	.....	.....	.....	.....	+.047	+.047	.....	−.024	−.065	−.006	−.032	.022
4 a. m	+.005	−.009	−.002	.....	.....	.....	.....	+.020	+.020	.....	−.030	−.030	−.040	−.033	.004
5 a. m	−.022	−.024	−.023	−.012	−.019	−.019	−.027	−.008	−.017	.006	−.033	−.051	−.057	−.047	.009
6 a. m	+.013	−.030	−.008	−.062	+.011	−.029	−.037	−.027	−.029	.017	−.060	−.064	−.079	−.068	.008
Mean of range between results	.....	.....	±.013	.....	.....	.....	.....	.....	.....	±.018	.....	.....	.....	.....	±.019

Camp Supply, Indian Territory.

Hour.	May.			Mean.	$\frac{\Sigma v}{m}$	Hour.	May.			Mean.	$\frac{\Sigma v}{m}$
	1.	2.	3.				1.	2.	3.		
a. m....	−.019	.....	+.021	+.002	.020	2 p. m....	+.002	−.004	−.022	−.008	.009
a. m....	−.026	+.035	+.003	+.003	.020	3 p. m	+.034	+.003	+.006	+.014	.003
a. m....	−.062	+.032	+.017	−.004	.039	4 p. m....	+.058	.....	.....	.....	.....
a. m....	−.079	−.004	.....	−.037	.042	5 p. m....	+.071	.....	.....	+.071	.....
a. m....	−.106	−.004	.....	−.055	.051	6 p. m....	+.074	.....	.....	+.074	.....
a. m....	−.112	−.017	−.062	−.063	.032	7 p. m....	+.088	.....	.....	+.088	.....
a. m....	−.059	−.040	.....	−.050	.009	8 p. m....	+.081	.....	.....	+.081	.....
m	−.026	.....	.....	−.026	.....	9 p. m....	+.084	−.001	+.004	+.028	.035
p. m....	−.002	.....	.....	−.002	.....						
Mean of range between results.....											±.027

Permanent Camp on Red River, Texas.

Hour.	May.					Mean.	$\frac{\Sigma v}{m}$	Mean, May 21, 28, 29.	$\frac{\Sigma v}{m}$
	21.	28.	29.	30.	31.				
6 a. m	−.044	+.02	−.010	−.067	−.087	−.038	.031	−.012	.016
7 a. m	−.046	+.02	−.028	−.077	−.105	−.049	.032	−.017	.016
0.27 a. m.....	−.041	−.03	−.027	−.185	−.013	−.059	.050	−.033	.006
2 p. m	+.002	.00	+.054	+.047	+.130	+.047	.036	+.017	.020
8 p. m	+.079	.00	+.046	+.076	+.157	+.072	.049	+.042	.028
9 p. m	+.041	−.02	−.044	+.021	+.100	+.020	.029	−.008	.034
9.27 p. m.....	+.045	−.02	−.048	+.006	+.050	+.007	.035	−.008	.035
Mean of range between results.....							±.037	.....	±.022

I can offer no explanation which can account for the extreme range in the results at this point, but that the final results are of value may be seen in the fact that the probable error of the final results and of a single observation for the altitude of this point deduced from comparisons with the record at Dodge City is almost the same as the same quantities deduced in the same way for the mouth of Tule Creek, a point where the range in the determination of the horary corrections was only half as great as at this camp. On the 30th and 31st of May great disturbance in the atmospheric pressure is reported at Dodge City. If these two days are omitted, the corrections become very nearly the same as those obtained for the general table, there being only an average difference of +0.005 inch between the two series in individual readings. I did not feel justified in throwing out these two days entirely, and they are incorporated in the work and included in the determination of the altitude.

Abnormal and monthly variations are not given, as the occupation of any one point was not lengthy enough to make any proper deduction therefrom. The barometrical pressure curve at Dodge City is given for the time of the operations of the survey, and also the curve of pressure of the barometers of the survey, reduced to the altitude of Dodge City.

In comparing these two curves, differences may arise from the following causes:

1st. Errors of reading the instruments at the two stations.

2d. Imperfections in the instruments themselves.

3d. Atmospheric changes affecting one station and not the other.

4th. Errors in supposed differences of altitudes used in reduction.

5th. Errors in reduction.

Assuming the personal and instrumental errors constant, and that

observations, if sufficiently continuous at two stations, will wholly or partially eliminate the errors from the third source, comparisons between the curves will give us a means of comparing the probable errors arising from the fourth cause, and will give us a correction of more or less value, depending upon the length of time of the observations and the distance between the stations. I have found by this means the following corrections for the deduced altitudes of the principal points:

Place.	Correction to altitude.	Probable error of altitude as deduced from observation.	
		Single observation.	Final result.
	Feet.		
Camp Supply	+41.4	±51.2	±15.5
Fort Elliott	— 6.7	±22.2	± 5.2
Red River Permanent Camp	+10.0	±37.2	± 8.1
Tule Creek	+20.1	±37.2	±10.
Cañonsito Blanco	—60.7	±58.0	±16.7

TABLE OF BAROMETRICAL READINGS AT DODGE CITY, UNCORRECTED FOR ALTITUDE, AND OF THE BAROMETRICAL READINGS TAKEN ON THE LINE OF THE SURVEY, REDUCED TO THE ALTITUDE OF DODGE CITY.

Date.	Dodge City. Reduced to 32°.	Line of survey. Reduced to 32°.	Difference.	Station occupied on survey.
April 27, 2 p. m.	27.291	27.282	—.009	On the road.
9 p. m.	.405	.462	+.057	Bluff Creek.
April 28, 7 a. m.	.493	.451	—.042	On the road.
2 p. m.	.411	.408	—.003	Redoubt Creek.
9 p. m.	.377	.343	—.044	Do.
April 29, 7 a. m.	.360	.267	—.093	On the road.
2 p. m.	.240	.238	—.002	Do.
9 p. m.	.227	.133	—.094	Sand Creek.
April 30, 7 a. m.	.144	.073	—.071	Do.
2 p. m.	.107	.027	—.080	Camp Supply.
9 p. m.	.114	.047	—.067	Do.
May 1, 7 a. m.	.374	.207	—.167	Do.
2 p. m.	.493	.462	—.031	Do.
9 p. m.	.636	.587	—.049	Do.
May 2, 7 a. m.	.721	.717	—.004	Do.
2 p. m.	.598	.637	+.039	Do.
9 p. m.	.439	.497	+.058	Do.
May 3, 7 a. m.	.205	.292	+.087	Do.
2 p. m.	26.985	.011	+.026	Wolf Creek.
9 p. m.	.917	26.875	—.042	Do.
May 4, 7 a. m.	27.067	.875	—.192	Do.
2 p. m.	.169	27.169	000	On the road.
9 p. m.	.212	.207	—.005	South Commission Creek.
May 5, 7 a. m.	.227	.196	—.031	On the road.
2 p. m.	.147	.155	+.008	Do.
9 p. m.	.158	.167	+.009	Washita River.
May 6, 7 a. m.	.033	26.986	—.047	On the road.
2 p. m.	.084	27.076	—.008	Fort Elliott, Texas.
9 p. m.	.272	.276	+.004	Do.
May 7, 7 a. m.	.449	.436	—.013	Do.
2 p. m.	.425	.456	+.031	Do.
9 p. m.	.515	.571	+.056	Do.
May 8, 7 a. m.	.478	.526	+.048	Do.
2 p. m.	.501	.491	—.010	Do.
9 p. m.	.538	.546	+.008	Do.
May 9, 7 a. m.	.507	.546	+.039	Do.
2 p. m.	.395	.446	+.051	Do.
9 p. m.	.390	.446	+.056	Do.
May 10, 7 a. m.	.385	.436	+.051	Do.
2 p. m.	.355	.346	—.009	Do.
9 p. m.	.299	.346	+.047	Do.
May 11, 7 a. m.	.301	.376	+.075	Do.
2 p. m.	.373			
9 p. m.	.473	.382	—.091	Old Cantonment.

Table of barometrical readings at Dodge City, &c.—Continued.

Date.	Dodge City. Reduced to 32°.	Line of survey. Reduced to 32°.	Difference.	Station occupied on survey.
May 12, 7 a. m.	27.612	27.607	−.005	Old cantonment.
2 p. m.	.523	.557	+.034	Do.
9 p. m.	.478	.487	+.009	Do.
May 13, 7 a. m.	.420			
2 p. m.	.346			
9 p. m.	.311	.330	+.019	Big Springs.
May 14, 7 a. m.	.206	.189	−.017	On the road.
2 p. m.	.130	.174	+.044	McClellan Creek.
9 p. m.	.095	.139	+.044	Do.
May 15, 7 a. m.	.073	.129	+.056	Do.
2 p. m.	.071	.229	+.158	Do.
9 p. m.	.224	.169	−.055	Do.
May 16, 7 a. m.	.429	.430	+.001	On the road.
2 p. m.	.392	.334	−.058	Salt Fork.
9 p. m.	.336	.399	−.063	Do.
May 17, 7 a. m.	.351	.352	+.001	On the road.
2 p. m.	.278	.401	+.123	Mulberry Creek.
9 p. m.	.230	.316	+.086	Do.
May 18, 7 a. m.	.250	.260	+.010	On the road.
2 p. m.	.185	.178	−.007	Red River, first camp.
9 p. m.	.162	.278	+.116	Do.
May 19, 7 a. m.	.303	.333	+.030	Do.
2 p. m.	.279	.313	+.034	Do.
9 p. m.	.261	.353	+.092	Do.
May 20, 7 a. m.	.274	.300	+.026	On the road.
2 p. m.	.248	.237	−.011	Red River, permanent camp.
9 p. m.	.238	.222	−.016	Do.
May 21, 7 a. m.	.233	.277	+.044	Do.
2 p. m.	.199	.207	+.008	Do.
9 p. m.	.194	.147	−.047	Do.
May 22, 7 a. m.	.213	.202	−.011	Do.
2 p. m.	.157	.187	+.030	Do.
9 p. m.	.395			
May 23, 7 a. m.	.504	.437	−.067	Red River, permanent camp.
2 p. m.	.505	.372	−.133	Do.
9 p. m.	.558			
May 24, 7 a. m.	.599	.527	−.072	Red River, permanent camp.
2 p. m.	.569	.510	−.059	Palo Duro First.
9 p. m.	.599	.590		
May 25, 7 a. m.	.557	.610	+.053	Palo Duro First.
2 p. m.	.500	.611	+.111	Palo Duro Second.
9 p. m.	.466	.631	+.165	Do.
May 26, 7 a. m.	.503	.651	+.148	Do.
2 p. m.	.453	.671	+.218	Do.
9 p. m.	.430	.611	+.181	Do.
May 27, 7 a. m.	.441			
2 p. m.	.387	.297	−.090	Red River, permanent camp.
9 p. m.	.367	.287	−.080	Do.
May 28, 7 a. m.	.320	.287	−.033	Do.
2 p. m.	.249	.307	+.058	Do.
9 p. m.	.292	.327	+.035	Do.
May 29, 7 a. m.	.263	.307	+.044	Do.
2 p. m.	.212	.167	−.045	Do.
9 p. m.	.203	.207	+.004	Do.
May 30, 7 a. m.	.123	.097	−.026	Do.
2 p. m.	26.949	26.892	−.057	Do.
9 p. m.	.886	.832	−.054	Do.
May 31, 7 a. m.	.814	.847	+.033	Do.
2 p. m.	.751	.702	−.049	Do.
9 p. m.	.866	.847	−.019	Do.
June 1, 7 a. m.	27.189	27.112	−.077	Do.
2 p. m.	.151	.062	−.089	Do.
9 p. m.	.181			
June 2, 7 a. m.	.244	.032	−.212	Red River, permanent camp.
2 p. m.	.306	.131	−.175	Cañoncito Blanco.
9 p. m.	.455			
June 3, 7 a. m.	.563	.461	−.102	Cañoncito Blanco.
2 p. m.	.551	.531	−.021	Do.
9 p. m.	.547	.551	+.004	Do.
June 4, 7 a. m.	.569	.591	+.022	Do.
2 p. m.	.488	.551	+.063	Do.
9 p. m.	.486	.531	+.045	Do.
June 5, 7 a. m.	.494	.644	+.150	Do.
2 p. m.	.408	.590	+.182	Do.
9 p. m.	.393	.517	+.124	Do.
June 6, 7 a. m.	.319	.531	+.212	Do.
2 p. m.	.208	.370	+.062	Do.
9 p. m.	.136	.372	+.236	Do.
June 7, 7 a. m.	.039	.224	+.185	On the road.

Table of barometrical readings at Dodge City, &c.—Continued.

Date.	Dodge City. Reduced to 32°.	Line of survey. Reduced to 32°.	Difference.	Station occupied on survey.
June 7, 2 p. m.	.091	.174	+.083	Camp Cent.
9 p. m.	.202	.319	+.117	Do.
June 8, 7 a. m.	.339	.324	−.115	On the road.
2 p. m.	.354	.330	−.024	Tule Creek.
9 p. m.	.312	.351	−.039	Do.
June 9, 7 a. m.	27.272	27.306	+.034	Do.
2 p. m.	.115	.141	+.026	Do.
9 p. m.	.067	.072	+.005	Do.
June 10, 7 a. m.	.111	.145	+.034	Do.
2 p. m.	.195	.111	−.084	Do.
9 p. m.	.323	.254	−.069	Do.
June 11, 7 a. m.	.420	.326	−.094	Do.
2 p. m.	.374	.366	−.008	Do.
9 p. m.	.405	.353	−.051	Do.
June 12, 7 a. m.	.656	.596	−.060	Do.
2 p. m.	.610	.562	−.048	Do.
9 p. m.	.565	.568	+.003	Do.
June 13, 7 a. m.	.532	.....	.....	
2 p. m.	.465	.475	+.010	Battle Creek.
9 p. m.	.450	.466	+.016	Do.
June 14, 7 a. m.	.442	.437	−.005	On the road.
2 p. m.	.373	.432	−.059	D Company Creek.
9 p. m.	.366	.452	+.086	Do.
June 15, 7 a. m.	.410	.479	+.069	Do.
2 p. m.	.348	.423	+.075	Do.
9 p. m.	.457	.460	+.003	Do.
June 16, 7 a. m.	.512	.....	.....	
2 p. m.	.416	.458	+.042	Mulberry Creek.
9 p. m.	.432	.472	+.039	Do.
June 17, 7 a. m.	.465	.547	+.082	Do.
2 p. m.	.466	.495	+.029	Do.
9 p. m.	.474	.534	+.060	Do.
June 18, 7 a. m.	.471	.586	+.115	Do.
2 p. m.	.409	.....	.....	
9 p. m.	.409	.566	+.057	Do.
June 19, 7 a. m.	.428	.327	−.101	On the road.
2 p. m.	.371	.428	−.057	Whitefish Creek.
9 p. m.	.356	.....	.....	
June 20, 7 a. m.	.335	.387	+.052	On the road.
2 p. m.	.270	.310	+.040	McClellan Creek.
9 p. m.	.259	.291	+.032	Do.
June 21, 7 a. m.	.226	.328	+.102	On the road.
2 p. m.	.188	.....	.....	
9 p. m.	.223	.114	−.109	Fort Elliott.
June 22, 7 a. m.	.294	.149	−.145	Do.
2 p. m.	.257	.067	−.190	Do.
9 p. m.	.351	.....	.....	
June 23, 7 a. m.	.397	.271	−.126	Do.
2 p. m.	.355	.186	−.169	Canadian River.
9 p. m.	.352	.....	.....	
June 24, 7 a. m.	.346	.....	.....	On the road.
2 p. m.	.278	.089	−.199	Willow Spring.
9 p. m.	.222	.....	.....	
June 25, 7 a. m.	.216	.120	−.096	Wolf Creek.
2 p. m.	.182	.052	−.130	Camp Supply.
9 p. m.	.189	.087	−.102	Do.
June 26, 7 a. m.	.219	.134	−.085	Do.
2 p. m.	.193	.126	−.067	On the road.
9 p. m.	.244	.113	−.131	Cimarron River.
June 27, 7 a. m.	.335	.271	−.064	On the road.
2 p. m.	.330	.312	−.018	Bluff Creek.
9 p. m.	.396	.372	−.024	Do.
June 28, 7 a. m.	.484	.....	.....	Dodge City.
2 p. m.	.506	.....	.....	Do.
9 p. m.	.521	.....	.....	

Mean barometric reading at Dodge City, 196 readings = 27″.325.

v = Diff. reading, Dodge City and line of survey.

m = Number of observations = 167.

$$r = 0.8453\frac{\Sigma v}{\sqrt{m(m-1)}} = 0.8453\frac{11.680}{\sqrt{167\times166}} = \pm.0''.059.$$

This may be considered as showing the general conditions of accuracy of the barometrical determinations during the survey inasmuch as all the errors enumerated above have been here considered, and the resulting probable error reduced to feet $= \pm 56.5$ feet may be useful in the comparison with other and similar series.

In preparing the following general table of altitudes the principal points occupied are referred to, and in the determinations the probable errors are calculated from the range in the various results. The accuracy of such comparison is doubtful and the formula should be applied to weighted observations, wherein the distance between the stations should enter. Some function indicating the amount of abnormal atmospheric disturbance should also enter, as is plainly indicated in the results of the determination at Camp Supply. As it is, however, the probable errors serve somewhat for comparison of the accuracy of results. The altitude of Dodge City was taken from the report of the Chief Signal Officer of the Army for 1876. The mean of the barometric observations at that point for the period in question gives a slightly different result. The column of No. of observations used, sometimes includes the mean of two barometers and at others of three. The profile of Tule Creek and of the Palo Duro and Tierra Blanca were obtained by using one barometer on the road, and comparing its record with that of one left at one of the camps occupied for a longer period.

TABLE GIVING ALTITUDES AND BAROMETRICAL READINGS AT POINTS OCCUPIED IN THE SURVEY OF THE SOURCES OF RED RIVER, TEXAS.

Dates when observations were made.	Station.	Difference in altitude between Dodge City and station occupied.	Number of observations used in determination.	Altitude.	Probable error of—		Mean barometrical reading—	
					Single result.	Final result.	Observed.	Deduced from difference in altitude and Dodge City mean.
		Feet.		*Feet.*				
	Dodge City			2,479			27.325	27.325
April 27 and June 27	Bluff Creek	— 75.1	3	2,404			27.439	27.399
April 27	Bear Creek Redoubt	— 471.4	1	2,008			.616	.820
April 28 and June 26	Redoubt Creek, Cimarron River	— 676.0	3	1,803			28.088	28.038
April 29	Kansas boundary	— 517.0	1	1,962			27.906	27.869
April 29	Gypsum Creek	— 960.4	1	1,519			28.096	28.346
April 29	Dog Soldier Creek	— 825.8	1	1,653			28.006	28.200
April 29 and 30	Sand Creek	— 825.8	2	1,653			27.971	28.200
April 30	Summit divide between Sand Creek and Beaver Creek	— 386.5	1	2,092			27.496	27.808
April 30 to May 3 and June 25	Camp Supply	— 577.7	11	1,901	±51.2	±15.5	28.106	27.934
May 3 and 4	Crossing Wolf Creek	— 533.3	3	1,946			27.463	.886
May 4	Willow Spring	— 387.7	2	2,091			.496	.732
May 4	South Commission Creek	— 237.7	1	2,241			.456	.574
May 5 and June 23	Canadian River	— 66.7	2	2,402			.241	.494
May 5	Washita River	+ 30.3	1	2,509			.136	.294
May 5 to 11 and June 21 and 22	Fort Elliott, Tex	+ 115.6	18	2,595	±22.2	± 5.2	.219	.205
May 12	Old Cantonment Creek	+ 218.2	3	2,697			.282	.099
May 13	Big Springs, North Fork	+ 269.0	1	2,748			.051	.046
May 14	Level of Staked Plains, between North Fork and McClellan Creek.	+ 550.7	1	3,030			26.599	26.757
May 14 and 15	McClellan Creek	+ 380.2	4	2,859	44.8	22.4	.775	26.932
May 16	Level plain between McClellan Creek and Salt Fork	+ 692.6	1	3,172			26.859	26.613
May 16	Salt Fork	+ 467.8	2	2,947			.883	.842
May 16 and June 16 and 17	Mulberry Creek	+ 626.8	7	3,106	29.5	13.2	.714	.680
May 18 and 19	First camp on Red River	+ 935.0	5	3,434	42.8	19.2	26.314	26.348
May 20, 22, 23, 28, to June 1	Permanent camp	+1,088.7	21	3,568	37.2	8.1	.153	.214
June 3 to 6	Cañoncito Blanco	+1,012.4	12	3,491	58.0	16.7	.455	.290
June 7	Camp Cent	+ 946.5	2	3,426			.278	.357
June 8 to 13	Mouth Tule Creek	— 189.1	14	2,290	37.2	10.0	27.518	27.523
June 13	Battle Creek	+ 131.0	2	2,610			.334	.189

June 14 and 15	D Company Creek	+ 295.2	4	2,777	26.8	13.4	.340	.010
June 19	Whitefish Creek	+ 548.6	1	3,028			26.862	26.759
June 20	McClellan Creek at the forks	+ 304.3	2	2,783			26.985	27.010
	Determined by comparison with permanent camp on Red River:							
May 24 and 29	First camp on Palo Duro	+1,131.7	3	3,611	32.8	18.9	26.416	26.171
May 25 and 26	Second camp on Palo Duro	+1,273.2	2	3,752			.340	.030
May 24	Rio Piedroso	+1,039.2	2	3,518			.543	.263
May 25	Canadian River	+ 755.4	2	3,234			.888	.549
May 27 and 28	Tierra Blanca Cañon	+1,162.1	5	3,641	57.0	38.4	.216	.139
	Determined by comparison with camp at mouth Tule Creek:							
June 9 and 10	Camp Scare Spring	+ 905.5	12	3,384	31.8	9.2	26.321	26.397
June 10	Head of water, Tule Creek	+1,053.8	1	3,532			.187	.259
June 11	Camp Sunday Spring	+ 830.0	9	3,309	15.0	5.0	.622	.474
June 10	Prairie west of Scare Spring	+ 995.3	8	3,474	44.9	15.8	.200	.307
June 9, 11, and 12	Between Scare Spring and cañon	+ 923.9	11	3,403	38.5	11.6	.440	.379

The line of profile here given crossed that of Lieutenant Whipple Topographical Engineers, on his survey of the thirty-fifth parallel i 1853–'54, near his camp No. 36, on the Canadian River. His camp wa higher up than my crossing, and was on the south side of the river mine being on the north. The two camps were probably only a fe miles apart in distance.

	Feet.
Lieutenant Whipple's altitude of his camp No. 36 is given at	2,162.
The crossing of the Canadian given in my table is	2,402.
Difference	239.

The line run to the Canadian River from my permanent camp on Re River touched Lieutenant Whipple's line again near his camp No. 43 and the altitudes are as follows:

	Feet.
Lieutenant Whipple's altitude of his camp No. 43	3,264.
Camp on Canadian River, May 25, 1876	3,234.
Difference	

The barometrical readings given in the report of Marcy and McC lan on the survey of the Red River of Texas in 1852 are not at all si lar to mine, and, as his altitudes are not calculated, I am unable to s gest the possible reasons for this difference.

BOTANY.

The following list of plants collected during the survey is necessa an imperfect catalogue of the flora of the country. The collection made by persons unfamiliar with botany, and generally at the close o hard day's work, when the leisure hours of camp were utilized in p by gathering specimens of plants at that time in bloom. Besides the n bers of individuals not yet in bloom, and therefore not reported, th were of necessity thus omitted in the list the names of all trees, fe and all non-flowering plants. The list is therefore submitted merely what it is worth of itself.

Upon reaching Fort Leavenworth, Kansas, the collection was pla in the hands of Dr. T. E. Wilcox, Assistant Surgeon, U. S. A., kindly offered his services. The classification has been prepared by h and through the kind assistance of Professor Wood, to whom all spe mens not recognized were submitted, the list was completed, and P fessor Wood's name will be found as the authority in these cases. T list may be considered as almost exclusively one of the flora of th Staked Plains of Northern Texas.

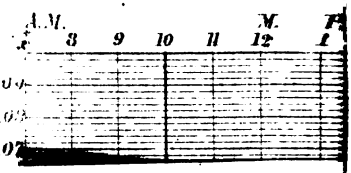
CATALOGUE OF PLANTS COLLECTED IN NORTHWEST TEXAS, NEAR THE HEADWATERS OF RED RIVER, BY FIRST LIEUT. E. H. RUFFNER, U. S. ENGINEERS.

RANUNCULACEÆ.

Anemone Caroliniana, Watt; Torr. and Gr., Fl. 1, p. 12.
Delphinium Azureum, Michæ; Torr. and Gr., Fl. 1, p. 32.
Ranunculus aquatilis, Wood.

PAPAVERACEÆ.

Argemone Mexicana, Linn.; Torr. and Gr., Fl. 1, p. 61.



CRUCIFERÆ.

sicaria.
Ludoviciana, D. C.
Angustifolia, Nutt.; in Torr. and Gr., Fl. 1, p. 101. Gray, Pl. Lindh., p. 145.
sturtium sinuatum, Wood.

PORTULACACEÆ.

linum Teretifolium, Pursh. Fl. 2, p. 365. Gray, Gen. Ill., t. 98.

MALVACEÆ.

alvastrum Coccineum, Gray, Gen. Ill., t. 121, pl. Fendl., p. 24.
alva coccinea, Nutt.
la coccinea, D. C., Torr. and Gray, Fl. 1, p. 235.
Illirhoë involucrato, Gray, Pl. Fendl., p. 15, and Gen. Ill., t. 117.
alva involucrata, Torr. and Gray, Fl., p. 226.
digitata, Nutt., in Jour. Acad. Phil. 2, p, 181; Gray, l. c.
Pedata.

LINACEÆ.

num Berlandieri, Hook. Brt. Mag., t. 3480; Engelm., in Gray, Pl. Wright 2, p. 25.

OXALIDACEÆ.

calis Violacea, Linn; Torr. and Gray, Fl. 1, p. 211.
Stricta, Linn; Torr. and Gr., Fl. 1, c.

ANACARDIACEÆ.

hus Trilobata, Nutt. in Torr. and Gr., Fl. 1, p. 218; Gray, Fl. Fendl., p. 28.
. Toxicodendron, Linn.; Torr. and Gray, l c.

VITACEÆ.

. Rupertis, Sheele in Linnæa, 21, p. 591; Gray, Pl. Lindh. 2, p. 165.

SAPINDACEÆ.

apindus Marginatus, Willd.; Torr. and Gr., Fl. 1, p. 255; Gray, Gen. Ill. 2, t. 180.

POLYGALACEÆ.

Polygala Alba, Nutt., Gen. 2, p. 87; Gray, Pl. Wright 1, p. 38; P. Beyrichii, Torr. and Gray, Fl. 1, p. 670.

KRAMERIACEÆ.

Kram ia lanceolata, Wood.

LEGUMINOSÆ.

Tephr ia Virginiana, Pers.; Torr. and Gr., Fl. 1, p. 295.
Glycy rhiza Lepidota, Nutt., Gen. 2, p. 106; Torr. and Gr., Fl. 1, p. 298.
Psora a
P. Te ifolia.
Dalea
D. F osa.
D. l ora, Ph., Wood.
Sopi sericea, Wood.
Peta. emon Violaceus, Michx., Fl. 2, p. 50, t. 37, f. 2; Torr. and Gray, Fl. 1, p. 310.
Petalo temon Gracile, Nutt., in Jour. Acad., Phil. 7, p. 92; Torr. and Gray, Fl. 1, p. 309.
Amorpha Canescens, Nutt, Gen. 2, p. 29; Torr. and Gray, Fl. 1, p. 306.
Astragalus Nuttallianus, D. C., Prodr. 2, p. 289; Torr. and Gr. 2, p. 234.
A. Caryocarpus, Ker. Brt. Reg., t. 176; Torr. and Gr., Fl. 1, p. 231.
A. Gracilis.
Baptisia Australis, R. Br.; Torr. and Gr., Fl. 1, p. 385.
B. Le ea, Nutt., Gen. 1, p. 282; Torr. and Gr. l. c.
Desm brachylobus.
Mimos agrans, Wood.
Hoffma eggia Jamesii, Torr. and Gr., Fl. 1, p. 293; Gray, Pl. Lindh. 2, p. 178.

ROSACEÆ.

Sanguisorba Annua, Nutt. in Torr. and Gray, Fl. 1, p. 429.
Poterium Annum, Hook., Fl. Bot. Am. 1, p. 198.
Rosa Blanda, Wood.

ONAGRACEÆ.

Œnothera Rhombipetala, Nutt. in Torr. and Gr., Fl. 1, p. 493; Kunze, in Linnæa, p. 57.
Œ. Sinuata, Linn.; Torr. and Gray, Fl. 1, p. 294.
Œ. Speciosa, Nutt. in Jour. Acad. Phil. 2, p. 119; Torr. and Gray, Fl. 1. c.
Œ. Lavandulæfolia, Torr. and Gr., Fl. 1, p. 501; Hooker's Lond. Jour. Brt. 6, p. Gray, Pl. Wright, 1, p. 72.
Œ. Serrulata, Nutt., Gen., 1, p. 246; Torr. and Gray, Fl. 1, p. 501.
B. Oblongifolia, Wood.
Gaura Coccinea, Nutt., Gen. 1, 249; Torr. and Gray, Fl. 1, p. 518.
G. Villosa, Torr., Amer. Lyc., New York, p. 200; Torr. and Gray, Fl. 1, p. 518; G Pl. Wright 1, p. 73.
Œnothera Canisceus, Torr., Wood.
Œnothera Missouriensis, Wood.
Œ. Hartwegii, Bentle., Wood.
Gaura Sinuata, Nutt., Wood.
G. Parviflora, Wood.

COMPOSITÆ.

Solidago Odora, Nutt.; Torr. and Gr., Fl. 2, 219.
S. Missouriensis, Nutt. in Jour. Acad. Phil. 7, p. 32, and Trans. Amer. Phil. Soc. (n. ser. 7, p. 327; Torr. & Gr., Fl. 2, p. 222.
Artemisia filifolia, Torr. in Amer. Lyc., N. York, 2, p. 211; Torr. and Gr., Fl. 2, p. 417.
Achillea Millefolium, Linn.; Torr. and Gray, Fl. 2, p. 409.
Riddellia Tagetina, Nutt. l. c., p. 371; Torr. and Gr., Fl. 2, p. 362; Torr. in Emory' Rep., t. 5; Gray, Pl. Fendl., p. 93.
Rudbeckia Hirta, Linn.; Torr. and Gr., Fl. 2, p. 307.
Echinacea Angustifolia, D. C., Prodr. 5, p. 554; Torr. and Gr., Fl. 2, p. 306.
Lepachys Columnaris, Torr. and Gr., Fl. 2, p. 315.
Rudbeckia Columnaris, Pursh., Fl. 2, p. 575.
Helianthus Petiolaris, Nutt. in Jour. Phil. 2, p. 115; Sweet Bril., Fl. Gard. (n. ser. t. 75.
Gaillardia Pulchella, Foug; D. C.. Prodr, 5, p. 652; Torr. and Gray, Fl. 2, p. 366.
Englemannia Pinnatifida, Torr. and Gray, in Nutt. Trans. Am. Phil. Soc. (n. ser.) 7, p. 433 Fl. 2, p. 283.
Crepis Runcinata, T. & G.
Thilespirunum gracile, Gr y; *Cosmidium*, T. & G.
Hellienium tenuifolium, N. (but the lower leaves are not entire.)
Lygodesmia juncea, Don.
Melampodium Cinereum, D. C., Prodr, 5, p. 518; Gray, Fl. Fendl., p. 78.
M. ramosissimum, D. C. l. c.; T. & G., Fl. 2, p. 271. *M. leucanthum*, Torr. & Gr., l. c.
Centaurea Americana, Nutt. in Jour. Acad. Phil. 2, p. 117; Bart., Fl. Amer. Sept., t. 50 Torr. & Gr., Fl. 2, p. 453.
Cirsium Undulatum, Spreng.; Torr. and Gray, Fl. 2, p. 456.
Aplopappus Hookerianus, Wood.
Aplopappus Spinulosus, Wood.
Hymenopappus Tenuifolius, Wood.
Townsendia Strigosa, Wood.
Cosmidium Gracile, Wood.
Pyrrhopappus Grandiflorus, Wood.
Melampodium Cinerium, Wood.
Berlandiera Incisa, Wood.
Eclimacea Angustifolia, Wood,
Erigiron tume, Wood.
E. radicatum, Hook, Wood.
Actinella linuariifolia, Wood.
Lygodesmia aphylla, Wood.
Chrysopsis villosa, Wood.
Aplopappus rubiginosus, T. & G. This plant agrees well in all respects with descri tions, but the rays are tinged with *blue*. They should be yellow. What does mean? Wood.

GENTIANACEÆ.

Erythraea Beyrichi, Torr. and Gr. Fl. 2, ined.

APOCYNACEÆ.

Apocynum Canabinum, Linn.; Hook. Fl. Bar. Amer.; 2, p. 51, t. 139.
A. hypericifolium, Wood.

ASCLEPIADACEÆ.

Asclepias Speciosa, Torr. in Ann. Lyc., 2, p. 218, and in Frémont's first rep., p. 95.
Asclepias tuberosa, Wood.

CHENOPODIACEÆ.

Monolepis chenopodioides, Mog. *B. trifolia*, Wood.

CONVOLVULACEÆ.

Evolvuus Pilosus, Nutt. Gen. p. 174, (as a synonym;) Trans. Amer. Phil. Soc. (n. ser.) 5, p. 195.
Convolvulus Lobatus, Engelm. and Gray, 1 Pl. Lindh. p. 44, (in a note.)
C. hastatus, Nutt. in Trans. Amer. Phil. Soc. (n. ser.) 5, p. 194, not of Thumb.
C. Nuttallii, Torr. in Emory's Rep., p. 149.
Ipomea leptophylla, Torr.; Wood.

SOLANACEÆ.

Physalis Pumila, Nutt. in Trans. Amer. Phil. Soc. (n. ser.) 5, p. 193.
Solanum Mexicanum, Wood.
Physalis lobata, Torr. Wood.

RHAMNEÆ.

Ceanothus Americanus, Wood.
C. Ovalis, Wood.

SCROPHULARIACEÆ.

Pentstemon acuminatus, Doug.; Wood.
Veronica Peregina, L.; Wood.
Pentstemon Cæruleus, Wood.

ACANTHACEÆ.

Ruellia stripens, Wood.

LABIATÆ.

Monarda Aristata, Nutt. in Trans. Amer. Soc. (n. ser.) 5, p. 186. Benth. in D. C. Prodr. 12, p. 363.
Scutellaria Resinosa, Torr. in Ann. Lyc. N. York, 2. p. 232. Benth. in D. C. Prodr. 12, p. 427.

VERBENACEAE.

Lippia Cuneifolia, Torr., in Ann. Lyc. N. York, 2 p. 234.
Lippia lanceolata, Wood.
Verbena Bipinnatifida, Engelm. and Gray, Pl. Lindh. i, p. 49; Shauer, D. C., Prodr. ii, p. 553.
Verbena erinoides. Wood.

BORAGINACEÆ.

Eritrichium Jamesii, *Myosotis suffruticosa*, Torr., in Amer. Lyc. N. York, 2, p. 225, D. C. Prodr. 10, p. 114.
Phacelia integrifolia, Torr.
Echinospermum Lappula, Wood.
Lithospermum longiflorum, Wood.

CUPULIFERÆ.

Quercus Undulata, Torr., in Ann. Lyc. 2, p. 248, t. 4.

GNETACEÆ.

Ephedra antisiphilitica, Meyer, (without flowers or fruit,) Wood.

CONIFERÆ.

Juniperus Virginiana, Lin., Michx. f. Sylv. 2, p. 353, t. 155; Torr., Fl., N. York, 2, p. 235.

COMMELYNACEÆ.

Tradescantia Virginica, Linn., Brt. Mag., t. 105, Bart. I, o. t. 141. Kunth. Enum. 4, p. Torr. Fl., N. York, 2, p. 333.

IRIDACEÆ.

Sisyrinchium Bermudianum, Linn., Torr., Fl., N. York, 2, p. 290.
Nemastylis acuta.

LILIACEÆ.

Allium reticulatum.

CYPERACEÆ.

Carex Muhlenbergii, Schk. Car. 2, p. 12, f. 178. Schwein and Torr. Car., p. 304. Tor Fl., N. York, 2, p. 394.
Carex lanuginosa, Wood.
Carex disjuncta, Wood, allied to *C. conjuncta*, Boott.
Scirpus pungens, Wood.
Eleocharis oltvacea, Wood.

EQUISETACEÆ.

Equisetum Hyemale, Linn. Pursh., Fl. 2, p. 652. Forr., Fl., N. York, 2, p. 482.
Equisetum Levigatum, Wood.

FILICES.

Adiantum Capillus Veneris, Wood.

GRAMINEÆ.

Uniola Latifolia, Michx. Fl. 1, p. 71. Ell. Sk. 1, p. 167 Kunth. Enum. 1, p. 425.
Poa Andina, (an imperfect specimen,) Wood.
Poa Michauxii, Kunth., Wood.
Hordeum jubatum, Wood.
Triticum repens, L. (? No root or leaves,) Wood
Poa Compressa, Wood.
Andropagon argenteum, Wood.
Festuca tenella, Wood.
Aristida purpurea, Wood.
Eatonia obtusata, Gr., Wood.
Tricuspis acuminata, Moma., Wood.
Elymus Sitanion, Schutt., Wood.
Elymus Virginicus B. *vaginatus*, a dwarf form 3-6 feet high spikes sheathed, Wood.

NYCTAGINACEÆ.

Allionia incarnata, L.
Oxybaphus angustifolius, Sweet., Wood.

POLEMONIACEÆ.

Gillia filifolia, Nutt.

PLANTAGENACEÆ.

Plantago Patagonica, Torr.
Stenosiphon virgatus ?

REPORT OF LIEUTENANT THOMAS M. WOODRUFF, FIFTH INFANTRY.

FORT LEAVENWORTH, KANSAS, *February* 1, 1877.

SIR: I have the honor to submit the following report on the insects collected by me during the exploration and survey of the headwaters of the Red River of Texas, in 1876:

My implements were very incomplete, and those I had were hurriedly constructed. They consisted of three nets which could be fastened to the end of a long pole, a couple of killing boxes, and two collecting boxes. These boxes were tin baking-powder boxes of different sizes. I also had two sets of trays or drawers, sixteen dozen pill-boxes in nests, raw cotton, long sharp-pointed pins, some glass bottles, and a pair of steel pliers. For killing and preserving the specimens, I used cyanide of potassium, chloroform, arsenic in solution, and alcohol. As far as my limited knowledge extended, I arranged the specimens under their general classes, and in every case I gave date and locality of capture. In doing the former, I was guided by Dr. A. S. Packard's pamphlets on the directions for collecting and preserving insects. I regret, however, that I had so little knowledge on the subject, for I lost many interesting facts concerning the habits of many of the specimens, and also failed to note many well-known species. In order to have the specimens properly classified, they were sent to Mr. Herman Strecker, of the Reading Society of Natural Sciences, to whose list I respectfully refer you. He finds about 126 different species.

I am greatly indebted to the officers and the men of the expedition for collecting many interesting and valuable specimens.

I am, sir, very respectfully, your obedient servant,

THOS. M. WOODRUFF,
Lieutenant Fifth Infantry.

Lieut. E. H. RUFFNER,
Corps of Engineers, Chief Engineer, Department of the Missouri.

CLASSIFIED LIST OF INSECTS BY MR. HERMAN STRECKER.

READING SOCIETY NATURAL SCIENCES,
Reading, Pa., November 9, 1876.

SIR: I herewith transmit a classified list of the insects forwarded to us in September last, which were collected by the expedition under your charge during the surveys and explorations of the region of the headwaters of the Red River of Texas, in May and June, 1876.

The general area from which the collection was made, was that parts of the "Llano Estacado," or Staked Plains of Texas, embraced between longitude 100° 30′ west to 102° west, and latitude 34° to 35° 30′.

My thanks are due to Messrs. Charles A. Blake and E. T. Cresson for aid in determining the Hymenoptera, to Mr. A. S. Fuller in the Coleoptera, and to Dr. Cyrus Thomas in the Orthoptera.

Very respectfully, yours, truly,

HERMAN STRECKER.

Lieut. E. H. RUFFNER,
Corps of Engineers, Chief Engineer, Department of the Missouri.

HYMENOPTERA.

CHRYSIDIDÆ.

Chrysis Clara, Cress., 1 ♀.

LARRIDÆ.

Larrada semirufa, Cress., 1.
Tachytes abdominalis, Say, 1.

SPHEGIDÆ.

Chlorion cœruleum, Dru., 1 ♂.

POMPILIDÆ.

Pompilus Aethiops, Cress., 3 ♂.
Pompilus tenebrosus, Cress., 1 ♀.
Priocnemis validus, Cress., 1 ♀.
Pepsis marginata, Beau., 2 ♀.

MUTILLIDÆ.

Mutilla californica, Rad., 3 ♀.
Mutilla fenestrata, St. Farg., 3 ♂.
Mutilla ferrugata, Cress., 1 ♂.
Mutilla Fulvohirta, Cress., 1 ♂.
Mutilla gorgon, Blake, 2 ♂.
Mutilla orcus, Cress., 1 ♀.
Mutilla oajaca, Blake, 1 ♂.
Mutilla Sayi, Blake, 1 ♂ var.
Mutilla simillima, Smith, 2 ♀.
Mutilla zelaya, Blake, 1 ♂.
Agama castanea, Cress., 1 ♂.
Agama tapajos, Blake, 1 ♂ var.

VESPIDÆ.

Polistes minor, Cress., 3 ♀.
Polistes texana, Cress., 11 ♀.

ANDRENIDÆ.

Augochlora fervida, Smith, 1 ♀.
Eunomia marginipepennis, Cress., 1 ♂.

APIDÆ.

Megachile gentilis, Cress., 1 ♂.
Mellissodes australis, Cress., 1 ♀.
Mellissodes menachus, Cress., 1 ♂.
Anthophora occidentalis, Cress., 1 ♀.
Bombus nevadensis, Cress., 1 ♀.
Bombus pennsylvanicus, De Geer, 3 ♀, 4 ☿.

LEPIDOPTERA.

RHOPALOCERA.

PAPILIONIDÆ.

Papilio asterius, Cram, 1 ♀. Tule Creek.

Differs from the normal ♀ form in the total obsolescence of the submarginal row of yellow spots on both the upper and under surfaces of primaries.

PIERIDÆ.

Pieris protodice, Bdl. et Lec., 2 ♂; one from Tule Creek, the other from Salt Fork.
Colias eurytheme, Bdl., 1 ♂ from Cañoncito Blanco, 1 ♀ normal, and 1 ♀ albino from Mulberry Creek.
Meganostoma cæsonia, Stoll, 1 ♂. Cañoncito Blanco.

These *Pieridæ* present no points of difference from those found in various other localities in the United States and Territories.

LYCAENIDÆ.

Thecla mopsus, Hubn., 1 ♂ 1 ♀. Tule Creek.
Lycœna melissa, W. H. Edwards, 1 ♀. Tule Creek.

NYMPHALIDÆ.

Euptoieta claudia, Cram.
Argynnis Columbina, Godt., 2 ♂ 1 ♀. Mulberry Creek.

One ♂, head of Red River, rather small, otherwise not peculiar.
Eresia Carlota, Reak, 1 ♀. Head of Red River.
Eresia Tharos, Dru., 1 ♂. Head of Red River.
Apartura celtis, Bdl. et Lec., 2 ♀ var. Tule Creek.

Both expand 2⅛ inches. They are of much the same reddish or tawny hue as the variety described by W. H. Edwards under the name of *Alicia*, but the outer half of the

rimaries is not blackish brown as in that form, but is reddish, with some slight pale-rown shading, differing but little from the ground color of the rest of the upper sur-ace. The most noteworthy point of distinction in the example is, however, in the resence of another ocellus on primaries, situated in cell 3 in a line with the one in ell 2, the two being of like size; nor are they larger than the largest one of the six n the inferiors; both have a large white pupil; beneath they are larger and are ringed ith yellow, and also pupilled with white. This description applies to both examples, xcept that the other has in cell 4 also an ocellus, making a submarginal row of four celli on superiors. This ocellus in cell 4 has a much larger white pupil than either of he other three, though on the whole it is smaller than the two in cells 2 and 3 and the ame size as its partner in cell 5. The ocelli on upper surface of secondaries have bluish hite or gray pupils. These two examples are by far the most interesting of the Lepi-opterous insects taken.

DANAIDÆ.

Danais plexippus, Lin., 4 ♂.
This species occurred in every locality visited by the expedition.
Danais Berenice, Cram, 1 ♀. Tule Creek.

HESPERIDÆ.

Pamphila iowa, Scud., 4 ♂. Tule Creek.
Pamphila ottoe, W. H. Edwards, 1 ♂, 1 ♀. Mulberry Creek.
Ægiale cofaqui, Streck., 1 ♀. Tule Creek.
Is of much greater size than the type from which the species was recently described, (in Proc. Acad. Nat. Sci. Phil.,) expanding fully three inches. It has also one more white spot, (situated somewhat toward the apex or under side of secondaries.) The sub-apical marks in primaries are also larger than is the type. I have adopted Felder's generic name as having priority over *Megathymus* of Scudder.

HETEROCERA.

ZYGAENIDAE.

Alypia octomaculata, Fabr., 1 ♀. Mulberry Creek.

SPHINGIDAE.

Deilephila lineata, Fabr. 1, larva.
Sphinx lugens, Wlk., 1 ♂. Salt Fork.

NOCTUIDÆ.

Hadena inordinata, Morrison, 1 ♂. Head of Red River.
Syneda ingeniculata, Morrison, 1 ♀. Cañoncito Blanco.
Bolina deducta, Morrison, 1 ♀. Salt Fork.

DIPTERA.

Tabanus atratus, Fabr.
Sarcophaga carnaria, Linn.
Tachina,———? Figure 18 on plate V of Glover's "Illustrations of insects Diptera," but without being named.
Lucilia Cæsar, Linn.

COLEOPTERA.

CINCINDELIDÆ.

Amblycheila cylindriformis, Say, 2 examples.
Cincindela pulchra, Say, 3.
Cincindela scutellaris, Say, 1.
Cincindela tranguebarica, Hübn, 1.
Cincindela punctulata, Fabr., 1.

CARABIDÆ.

Pasimachus elongatus, Lec., 1.
Ebarthus incisus, Lec., 7.
Harpalus calignosus, Fabr., 2.
Harpalus pennsylvanicus, Deg., 1.
Chlœnius tomentosus, Say, 1.
Cymindes abstrusa, Lec., 1.
Helluomorpha, texana, Lec., 1.

HYDROPHILIDÆ.

Hydrophilus triangularis, Say, 1.

STAPHYLINIDÆ.

Creophilus villosus, Grav., 2.

DERMESTIDÆ.

Dermestes lardarius, Lin.
Dermestes marmoratus, Say, abundant.

COCCINELLIDÆ.

Hippodamia glacialis, Fabr.
Cyclonida abdominalis, Say.

HISTERIDÆ.

Saprinus oregonensis, Lec.

SCARABÆIDÆ.

Phanaeus carnifex, Lin., 1 ♂.
Trox suverosus, Fabr., 2.
Canthon hudsonias, Forst, 1.
Lachnosterna glabricula, Lec., 1.
Iostegoptera lanceolata, Lec., 1 ♂.
Anomala binotata, Gyll., 2.
Strigoderma arboricola, Fabr., 1.
Euryomia Kernii, Hald., very abundant and in many varieties.

BUPRESTIDÆ.

Melanophila miranda, Lec., 1.
Chrysobothris femorata, Fabr., 1.

ELATERIDÆ.

Lacon rectangularis, Say, 3.

LAMPYRIDÆ.

Photuris pennsylvanicus, De G., 1.

CLERIDÆ.

Thanasomus spinolai, Lec., 2.

CERAMBICIDÆ.

Batyle ignicollis, Say, 3.
Batyle suturalis, Say, 2.
Typocerus cinnatus, Neum., in great numbers.
Mecas inornati, Say, 1.
Moneilema anulatum, Say, 3.

CHRYSOMELIDÆ.

Chrysomela exclaimationis, Rog., 1.
Plagiodera confluens, Rog., 2.

TENEBRIONIDÆ.

Eleodes sponsa, Lec., 2.
Eleodes tricostata, Say, 3.
Eleodes obsoleta, Say, 2.
Eleodes extricata, Say, 2.
Eleodes acuta, Say, 1.

MELOIDÆ.

crobasis imaculata, Say, 6.
crobasis segmentata, Say, 3.
cauta ferruginea, Say, 5.
nognatha lurida, Lec., many examples.
nognatha discolor, Lec., 3.
athium minimum, Say, 1.
icis canna, Lec., 1.

CURCULIONIDÆ.

enophorus 13-punctatus, Ill., 4.

HEMIPTERA.

lgulus oculatus, Fabr., 1.
ochymena arborea, Say, 5.
achia histrionicha, Hahn., 2.
ptoglossus phyllopus, Lin., 7.
iomerus spissipes, Say, 2.

ORTHOPTERA.

GRYLLIDÆ.

ryllus abbreviatus, Serv., 1 ♀, 3 pupæ.

LOCUSTRARIÆ.

deopsylla robusta, Scud., 3 ♂.

ACRIDII.

aloptenus bivittatus, Uhler., 1, pupa.
esperotettix viridis, Thos., 2 ♂, 3 ♀, 1 pupa.
Edipoda corallipes, Hald., 2 ♂, also pupa of either this or the allied *Œdipoda discoidea*, Serv.
rimerotropis citrina?, 1 ♂.
In reference to this example Dr. Thomas says: "I am not positive; it is possible that belongs to *T. vinculata*, a very closely allied and scarcely distinct species."
ragocephala pacifica, 1 ♂.
crolophitus hirtipes, 2 larvæ.

BLATTARIÆ.

schnoptera unicolor?, 3 ♂, 2 ♀.

NEUROPTERA.

LIBELLULIDÆ.

Æschna heros, Fabr., 3.
Libellula trimaculata, De G., 2.

GEOLOGICAL NOTES.

The Staked Plains of Texas, wherein are found the sources of the Red River, present features favorable to geological research in the fine sections exhibited in the various cañons made by the different streams. To the student who visits these places, the first view seems fraught with promise of glorious results. Strata, vivid in color and various in composition, lie clear cut in sheer cliffs before his eyes, and invite a study made easy. And as he passes from one cañon to another, and

finds the whole country seamed by the net-work, the fortuitous labor nature appears almost supererogatory. Standing by the brink he s the solemn front of the huge mesa break down at the edges, and a m of rolling or abrupt and rough hills succeed the ceaseless long, gen swell of the plains' surface proper, and the field for study increases a swells to vastness. But the reality is a disappointment. The rolli swell of the general surface is participated in by the underlying roc and cañon after cañon throughout their whole extent present in gene but the same section, different only as the erosion has been greater, from slight local causes. So the grand walls of the grand cañon, wi their brilliant cliffs and spires, their castellated hills and cathed ruins, red, and red, and red, are again encountered in the smaller trib taries, until the red sandstone goes under the surface, and the chal tops of the cañon walls are found from one to the other until they t disappear, the very water-courses cease to be, and the unbroken prai reigns supreme.

Again the series of strata which do form the field for study are vague coarse and unattractive, upon close inspection, and the absence of fos life makes their stony pages almost the blank leaves of nature's volum unless, perhaps, they are instead the highly decorated pages of h book of illustrations only.

One thing, however, can be read everywhere, and that is the effects aqueous power on a grand scale—commensurate with the boundle area at nature's disposal when forming these fields to her taste. Th section which is here presented will describe the country between longi tude 101° and 102° west from Greenwich, and between latitude 34° 3 north and latitude 35°, or about 60 miles east and west, and 30 north and south. As I shall point out, the same, or a similar section, may b expected through the whole region from this to Dodge City, or on line running a little east of north.

The thickness of the various strata varies at points, but not to an great extent, and within the region as given I have myself verified th general section at nearly every point, certainly at places within sight o one another, and so situated that no serious difference could occur.

I shall commence at the top, and describe the series in descendin order.

The general surface of the plains is gently undulating, and sometime in such great swells as to present all the appearance of distant hills o mountains, even, when magnified by the mirage and with the heightene illusion of the level, where, with nothing to serve as a comparison, th judgment often fails to locate the distance. A noticeable instance o this swell and depression, this wave and its trough, occurs at the hea of the main cañon, where a north and south wave has made a trough and the swell of which is cut through in the minor cañons of the Pal Duro and the Tierra Blanca, 10 miles to the west of this. Again th bluffs of the cañon of the southern stream rise up to the traveler fro the north.

At the permanent camp, 8 miles east of the head of the main cañ the drift and alluvium may have been 75 feet in thickness, and at C ñoncito Blanco this thickness may have been equal o

No. 1. Drift, 75 feet.

less. The drift is fine and gravelly, or at times sand though never enough so to make the roads troublesome; the surface almost always hard.

Near the Tule Cañon, farther to the south, the drift sometimes e tirely disappears, or is found only in the side arroyas or drainage cha nels, and the chalky limestone of No. 2 is found frequently exposed

e level surface of the plains, while the outcrop near the cañons almost ecludes the existence of drift above.

No. 2. Chalky limestone, 75 to 100 feet.

No. 2 is a chalky limestone, very friable and weathng into minute fragments, with rectangular joints. . fossils were found, and it was difficult at any time to get access to e limestone stratum, so extensive was the disintegration. This numr was seen at every place where the summit of the general level was et, and was last seen at Bluff Creek, near Fort Dodge, and on the airie between that point and the Arkansas River. It will be noted at the altitude of Dodge City is about that of Fort Elliott, and the ne joining the same may be considered a strike line of the section der description.

No. 3. Compact limestone, 5 to 10 feet.

No. 3 is a layer of compact limestone, almost marble, of nooth grain, but conchoidal in fracture, and inclined to eak into small rectangular fragments. This seems to contain no fosls though very carefully examined for such. It is very firm and porlyritic in appearance, with whitish blots. The color is white or light ray, sometimes with a pinkish tinge in the sunlight. It will be seen as ne upper decided outcrop in the views given of all the cañons. It is the pper water-bearing rock, and when it disappears under the surface the head of the Palo Duro, Tierra Blanca, Tule, and Cañoncito lanco, there will be found the head of water. It and the number just bove it seem to be quite insoluble, as the water of these springs is ngularly sweet and pure. This rock is used in the construction of Fort lliott, where it is burnt for lime, and where its small and convenient ze at the quarry makes it suitable for the foundations of the light ame-houses of that post. At this point it is not far distant to the north a spur of the plains which pushes to the east, and is the divide beween the Washita and the North Fork of Red River. This number as not noticed again unless, perhaps, in the high land between the heads f Bear Creek and Bluff Creek in Kansas.

No. 4. Clay sometimes sandy, sometimes gravelly, 75 to 100 feet.

No. 4 is a clay, sometimes sandy, sometimes gravelly, but ever stone, although very compact. This presents curious eatures. On the Red River and the Palo Duro and Tierra Blanca, on the nargin of the cañon wall were found at places immense quantities of alcified and silicified (sometimes) roots which seemed the stratum in all lirections. Trunks and butts of trees were found above in No. 3. So xtensive was the calcified fibrous character at times, that the appearnce was almost that of a coral bed. In other cañons this feature seemed acking in this number, and from the fact that upon excavating into the ank, the roots were thought to diminish in quantity and lessen in size as he bank was entered, it appeared likely that the trees were located then, s now, on the margin of a water-course. No fossil-leaves were found; othing but the petrified wood so generally reported upon by every raveler in these parts. The formation of this number seems to have een quite rapid from the evenly smooth character and from the fact hat pockets of sand and gravel were found in considerable quantity esting upon the next lower number. These pockets evidently belonged to the number under description, and were formed by the sifting and settling of their contents through the lighter mud of the upper part. In these pockets were discovered the first fossils. At the Cañoncito Blanco, wherever exposed, shells could be found by a little search, but no shells were found in this number except in these pockets. The shells were all lamellibranchs, and were abundant in number, but of few varieties. I have spoken more in detail of them in another place. All were more or less water-worn, and appeared in general to have been brought or

washed there, rather than to have been left by their wearers. At n other place were the shells so abundant as in Cañoncito Blanco, thoug a few were found in the Tule and in Mulberry Creek.

No. 5. Sandstone conglomerate, 6 to 30 feet.

No. 5 is a sandstone conglomerate, compact in texture bu easily worn by water or weather. The gravel found in it i small and is not very abundant. A few fossils were found and eve occasional pockets. Generally, however, the conglomerate was quit free from shells.

No. 6 consisted of from 75 to 100 feet of red sandstones or clays some times passing into shales. Occasionally were beds o white, shaly sandstones, and sometimes almost clear san or even partially conglomerate. Very few shells wer found, but these were believed to have different varieties than those o the upper number, the difference being, perhaps, in Ostræa. This num ber varies very much, running through all the varieties of sand an clay and their rocks. Shales are light-colored or red, or sometime dark, and in these shales are found springs at several points. Th number also varies considerably in thickness and in many places give less than the minimum here quoted.

No. 6. Red sandstone shales and clays, 75 to 100 feet.

No. 7 is a hard dark-colored sandstone withstanding both water an weather. It is heavy and compact, and by its resistance i forms the second check in the formation of the cañons, th upper limestone being the first. The main falls of the Red River ar formed by this layer, and the narrow gulley or trench described as cu in the rock below the falls could have been possible only in this number These falls, 25 or 30 feet high, are reproduced in the Cañoncito Blanco by the same stratum and at a less height, and again in the Tule Cañon are found the same. Its firmness and dark color make it bold in relief and in appearance wherever the cañon-walls are precipitous. Occa sional pebbles and gravels are found, but no fossils have been noted This rock supports the last of the good water in descending order, and springs or running water found lower than this will be apt to be alka line. We have thus far described a section from 325 to 455 feet in depth, and as yet the gypsum has not been encountered. Moreover the characteristics of the numbers already specified are quite distinct and are easily recognized. The main cañon cuts fully 12 miles of its course before these are passed through, and our camping places on the Mul berry, the Salt Fork, the Upper McClellan Creek, and the Big Spring on North Fork, as well as Fort Elliott itself, and the creek at which it is supplied with water, are all found within the limits of so much of the section.

No. 7. Hard sandstone, 15 to 50 feet.

On ascending the divide from Bear Creek, Kansas; that is, in passing out of the valley of the Cimarron, we also pass through the lower o these numbers, and there are outcrops of conglomerate and sandstone containing not only the same fossils already obtained and alluded to, but many others of similar varieties. Many specimens of the *Ostræa Pastina* are found in good condition and very little water-worn. It ap peared to me that much the same varieties were obtained at Bear Creek that were collected on the divide between Beaver Creek and Sand Creek just north of Camp Supply, and that, in addition thereto, the small shells of Cañoncito Blanco were added, which were not found, certainly in numbers, at the outcrop near Camp Supply. It bore every appear ance that the formation at Bear Creek was contemporaneous with that of the lower portion of the section, as so far described, and that the more finely comminuted elements of the Staked Plains, the water-worn speci mens, the less number of varieties, and the smaller shells, all indicated

t Bear Creek was nearer the edge of the cretaceous ocean at that time, l that the Red River country was probably in deep and quiet water. ight add that no bowlders, or even large gravel, are found in the Red 'er country in the conglomerates of the whole section.

t is difficult to separate the lowest number into distinct and definite individuals. A confused mass of red sandstones and clays or shales are found as low as the cañon-walls extend. Where the sandstones predominate, as in the Tule Cañon, a mass- and striking cliff of brilliant red, 200 feet and more in height, rises ›er from the stream. When the clays are in excess, or clays and ıles or slates; the weird castles and churches, and brilliant mockeries the Red River itself are seen. In this number the occasional or at ıes more numerous or thicker beds or layers of gypsum are found. e gypsum is not found above No. 7. The gypsum deposits are scat- ing and varied in importance as well as in colors. All water found wing beneath the lower surface of No. 7 is apt to be tainted, and no ception of a fresh, sweet spring was found. There may be light- lored sandstones, and, at times, limestones in beds or thin layers may seen. Occasionally a bluish tint is found in the shales. The gyp- m is generally white or light-colored; but all colors are overwhelmed th the general vivid red of the whole land. Beds of conglomerates are en, and from one such a few of the small shells of the same varieties, as Cañoncito Blanco, were obtained. This was located not far from Camp ut, and probably 8 miles north of Tule Cañon. A few of the same ere also seen in position not far from D Company Creek camp. It ems hardly necessary to dwell on the peculiarities of this region, so ten and well described.

8. Sandstones, , and clays, et and more.

It seemed worthy of remark, however, that the barometer confirmed y own conclusions while on the line of march. The mouth of Tule reek and the camp on Sand Creek, 9 miles north of Camp Supply, are ›out at the same altitude, and they have nearly, if not quite, the same ›ological altitude. The water of Sand Creek is nearly, if not quite, ı disagreeable as that of the Tule. Camp Supply is on a higher level ıd the water is somewhat better, though, I think, quite disagreeable. ı crossing the divide between the Beaver and Sand Creeks, the top layer a conglomerate cemented by lime, with a great abundance of shells various varieties. I think this is of the same age as the layer ›oken of as near the Camp Cent Cañon. These shells were not much ater-worn, and were in very great abundance, more so than at any :her point visited on the trip.

The vivid gullies and arroyas and vistas seen from the summit of this ivide, as one looks to the north down the washed slopes, are as attract- 'e as many views in the cañon 150 miles to the south. Gypsum out- :ops are met with between this and the Cimarron, which stream again xhibits the characteristics of the gypsum formation. The rise from ıis up the bluffs of Bear Creek brings us out of the region again to ıore pleasant surroundings.

The profile shown by the barometer is one of general level to the north ıd south, and a long easy slope from the west to the east. The upper ›vel is well preserved, and reappears in detached portions as far as the ıntelope Hills on the south of the Canadian and east of the one-hun- redth meridian. The east and west streams have cut much the same ind of channels, and the side streams are all constructed in the same ıshion. So long as the upper limestone remained in situ the first diffi- ulties were great; but, as is shown by the shapes of the denudation, ıe climate has in general been mild and much the same as now, the

rains moderate, and the only effects of unusual powers are shown the commencement of the formation of the cañons. The easy roll of t ground gave inequalities to the surface which formed ponds and lak To-day are many basins of size enough to be called small lakes. Fill by the rain, they sometimes are of a depth as great as 10 feet, and ma are seen filled every year to a depth of 2, 3, or 4 feet. The largest these lakes in times past found its outlet over its rim in a small strea which wore away the hard limestone by degrees. At length the tim came when this stratum was entirely gone, and the softer material belo disappearing rapidly, an extra rainfall, perhaps, carried the small fall exit for the lake back to its brim, and the large mass of water was s in motion. Tearing down its outlet, the sand, shales and clays we swept away; the unsupported upper layers caved into the channel, a were also carried off by the rush; the wild torrent now with its gr fall and huge volume tore its way through the harder sandstone belo and the sharp-cut heads of each cañon were made at one great effo The lake disappeared, the cañon-walls were gradually shaped by t rains, but not very much, and the network of these water-courses e tended backward toward the head of the stream, as the additional heig given by the scouring out of the lower channels made the outbreak the upper lakes more effective and more easily begun. As each fre torrent tore down the main stream it lent its effort to alter the shape its bed. Sometimes it widened it, sometimes it cut a new channel, leavi the bed of the former stream to one side and at a higher level to be cu up into valleys and gullies afterwards. As soon as the main work wa done the power was exhausted. The light fall of rain was never enoug to smooth down and round the sharp-cut walls into gentle slopes of quie hills, and the formation of soil was impossible for this reason. Th absence of soil and rain prevented the accumulation of vegetable lif especially trees, and the whole part of the country since its elevati above the level of the cretaceous sea appears to have been that of lake region with a scant neighboring flora, small outlets bordered b trees, a cataclysm—perhaps covering some few years—of cañon form tion; and the same quiet life of to-day ever since that time. The sma stream going down the main cañon has only cut a few hundred yard backward through the sandstone at the falls, and this work might easil have been done in hundreds of years by the present stream.

There are definite bounds now visible to the ancient lakes whic formed the main cañon, that of Cañoncito Blanco and the Tule. Th evidences are also patent of a similar origin to the Mulberry Cree Cañon.

In the geological report of Lieutenant Whipple's Report, vol. III, Pacif Railroad Surveys, the Antelope Hills are described as having "whit limestone" for some of the upper beds. To the west of this point, b tween the Washita and the Canadian, were found fossil *Ostracea* in limestone 5 feet thick, and of a whitish gray color. (P. 19.) "Th only representation of this formation found in the collection is the well known cretaceous fossil "*Gryphœa Pitcheri.*" The sections given on page 24 and 25 represent the edges of the Staked Plains, and are all de scribed as having "white limestone" for the upper rock, in one cas giving 10 feet for the thickness. Underneath this is given "calcareou conglomerate," "sandstones and marls," and "yellow limestone, with bluish-gray beds, at the bottom containing *Ostrœa* ———[?]"

The last section quoted is of Mount Tucumcari, in the valley of th Canadian, about longitude 103° 40′ west, or more than 50 miles beyon my farthest western point. These sections and descriptions are muc

re in accordance with my own than those recorded in Marcy and Clellan's report on the Red River, and confirm me in my belief that e geology of the northern part of the pan-handle of Texas, and exding some distance north into the Indian Territory, is one and the ne.

The fossils which were brought back were sent to Prof. O. C. Marsh identification, he having kindly promised to do this as a labor of love. e has not as yet sent me the list, but I hope it may be received in ne to be printed with this report. I have endeavored myself, with the ght sources of comparison at my disposal, to classify or describe some those brought back. By far the greatest number of specimens obined at the Cañoncito Blanco and in the cañon wherever found conted of *Ostræa*. The varieties figured in Meek's report on Cretaceous vertebrata, United States Geological Survey of the Territories, as the *strœa Patina. Var. A, B, and C* are well represented, in especial the tter named. As I lay no claims to being an expert in palæontology, I ay be pardoned if I state that these figures and those of the *Gryphœa itcheri*, as given in Vol. II, Pacific Railroad Reports, seem to me to run e one into the other, and that it might be difficult to say at times hether an individual should belong to one or another of the four mes quoted. At any rate, whether right or wrong in this, I am cerin that I have specimens which exactly represent all the plates and arieties given and drawn in the volumes cited.

The next most prominent fossil in point of numbers I have concluded be the *Ostræa Glabra*, (p. 509 Meek.) The fossil so named occurs in reat quantity and of all sizes from 1 to 2 inches in length. In addion to these I have found, I think, specimens of the *Ostræa inornata*, leek, p. 14; *Mactra (Cymbophora) Alta*, 210 Meek; *Callista Pellucida*, 37 Meek; *Protocardia Para*, 176 Meek. I have tried to make myself elieve that among the specimens collected there were also exhibited *strœa congesta*, *Inoceramus problematicus*, or indeed any variety of *Inceramus*, but I failed, and at present I do not believe these varieties ere found. It so happens that the fossils named so far are located in o. 4, No. 5, and upward of Hayden & Meek section of the cretaceous ocks of the Northwest. I am not familiar with the appearance of this ection as described, nor have I seen the upper numbers as quoted in he various reports of the Upper Missouri. It also happens that many f the fossils quoted in the general section as characteristic were not ound by myself, and it is again worthy of remark that if the Staked lains section does belong to the upper rocks of the cretaceous period he colors and general appearances of Nos. 4 and 5 will not fairly dcribe the southern rocks. Professor Hayden describes the northern ands as dark and somber, and no mention of red is made above the Dakota group. The fossils of the Fort Benton group, as figured, are ertainly *not* characteristic of the Staked Plains, and without attempting to place these strata, I merely desire to call attention to these points, nd to note particularly the force of my observation, that all the fossils o far named are much *water-worn* and generally small in size, and must have been brought some distance.

The fossils found at Camp Supply are very abundant, and some portions of the rock seem entirely composed of them. The varieties of *Ostræa* quoted are found, and I thought I could safely call two or three specimens *Inoceramus*. Many and interesting individuals of *Scaphites* were noted and were all well marked and very little water-worn. *Scaphites Conradii* was noted, and it is believed *Scaphites Nodosus*, *Phola-*

domya (*Procardia*) *Hodgii*, Meek, p. 219, was marked as one examp
though others were thought to have been possibly the same.

Many specimens of *scaphites* of different varieties were recogniz
and a much convoluted shell was thought to be a portion of an amm
ite. A strongly-marked bivalve, of beautiful shape and well preserv
awaits recognition, and there are many other varieties which it is hop
will be classified in time.

Perhaps it would be proper at this point to say that at the heads
the various streams, and sometimes in accumulated beds in the lo
parts of their courses, and in the ponds on the prairie, were found she
of land and fresh-water varieties of *Physæ*, *Limnæa*, *Planorbis*, a
Unios. These were not found alive, perhaps because no search w
made for them; but I recollect that the head of the Paloduro was
especial marked by great quantities of these shells.

REPTILES.

The party did not attempt to make a full collection of the reptil
The full and well-illustrated report on this subject in Marcy and McCl
lan's report seems to have about covered the entire ground, at least
one not a specialist. A few specimens collected were sent to the Rea
ing Society of Natural Sciences, and the accompanying letter gives th
list of all specimens so sent.

It may be said, however, that all such belong to species which a
abundantly represented everywhere along the line of the survey.

LIST OF REPTILES PREPARED BY DR. M. A. RHOADS.

READING SOCIETY OF NATURAL SCIENCES,
Reading, Pa., December 22, 187

SIR: I have the honor to transmit the following list of reptiles forwarded to th
society, which were collected by the expedition under your charge during the surve
of the region of the head-waters of the Red River of Texas, in May and June, 1876.

Very respectfully,

M. A. RHOADS, M. D.

Lieut. E. H. RUFFNER,
Corps of Engineers, Chief Engineer Department of the Missouri.

Order SAURIA. Genus CROTOPHYTUS.

Crotophytus Collaris, Holbrook.

Genus TAPAYA.

Tapaya Douglasii, G.

Order OPHIDIA. Genus CROTALUS.

Crotalus ledamantus, Beauv.
Crotalus Confluentus, Say.

Genus HETERODON.

Heterodon Nasicus.

Also along with the above—
Mygale Hentzii.